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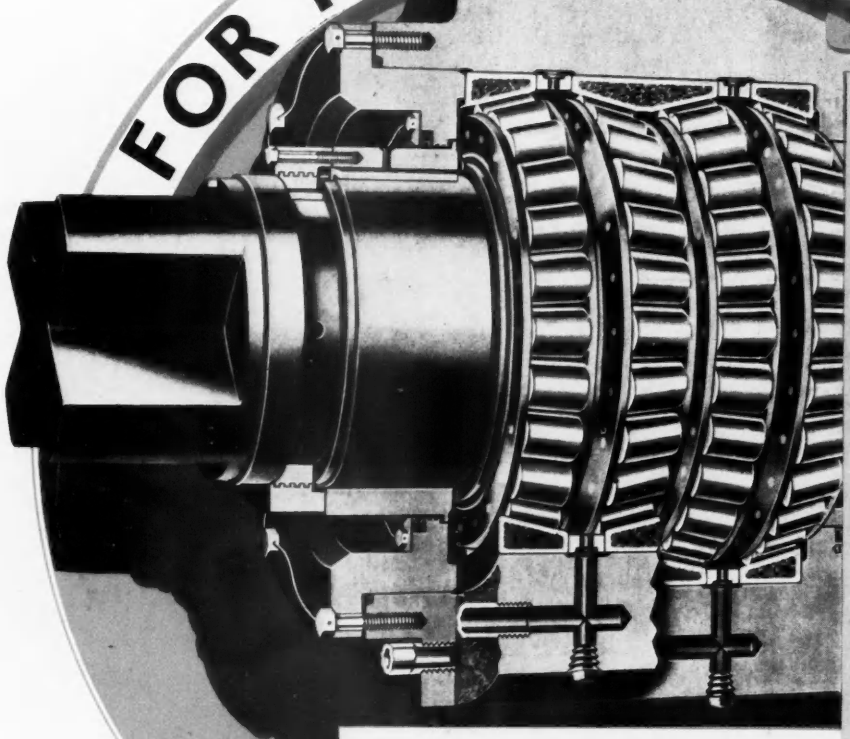
FOR HEAVY DUTY—



TRADE MARK TIMKEN

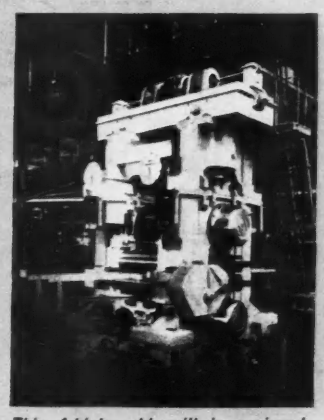
Timken tapered roller bearings, having a great capacity for journal load and also for resisting combined journal and thrust loads, are being extensively used throughout the heavy industries.

The above illustration shows a typical Timken four-row roller bearing such as is used on the world's heaviest capacity rolling mill fitted with anti-friction bearings. The lowest of the four small illustrations shows a partly assembled two-row rolling mill bearing for the back-up rolls of a large 4-high mill, together with a pair of work roll bearings.

The long life and reliability of the Timken tapered roller bearings eliminate the troubles and mill stoppages commonly associated with the ordinary plain bearing and enable high outputs to be obtained with improved accuracy, rolling speed and finish.

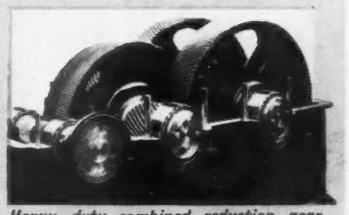
Timken tapered roller bearings are also built into machine tools where their 'rigidity' and high capacity to resist combined thrust and journal loads are of great value. Further, they can be pre-loaded when necessary and still further increase spindle rigidity.

Typical examples of Timken tapered roller bearing equipment are shown in the small illustrations at the side.

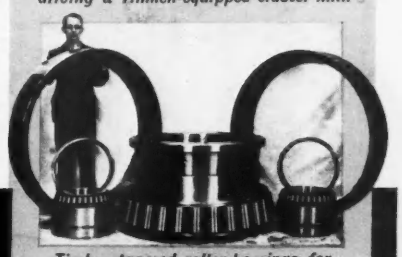


This 4-high cold mill is equipped with Timken tapered roller bearings.

A further example of a Timken equipped 4-high cold mill.



Heavy duty combined reduction gear and pinion stand, mounted throughout on Timken tapered roller bearings, for driving a Timken-equipped cluster mill.



Timken tapered roller bearings for a heavy 4-high cold sheet mill.

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A Seven-Day Journal

Television.

THE report of the Television Committee, published on Thursday, January 31st, contains carefully considered proposals for the establishment of a service in London. At a single transmitting station the systems of Baird Television, Ltd., and the Marconi E.M.I. Television Company, Ltd., are to be given an extended trial under strictly comparable conditions by using them alternately. In the light of the experience gained, the Advisory Committee will proceed with the planning of additional stations until a complete network has been established. The total number of stations and the speed at which they are provided will, naturally, depend upon the results obtained from the first station, the popularity of the service, finance, and other factors. Programmes covering many hours of the day will not be provided at the outset. An hour's transmission in the morning or afternoon for trade demonstrations and two hours in the evening are suggested for the initial service, whilst, as regards the future, the British Broadcasting Corporation and the Advisory Committee will doubtless be guided by experience and financial considerations. The cost of providing the London station, including all running and maintenance expenses, programme costs and amortization charges, on the basis of comparatively rapid obsolescence for the period up to December 31st, 1936, when the B.B.C.'s present charter expires, is estimated at £180,000. By far the largest factor in the figure is the programme cost which, in the event of the scheme proving a success, will increase just as the cost of sound programmes have risen. At this early stage the Committee has not budgeted for a programme comparable in duration, variety, or quality with existing sound programmes, but it is considered that the service should be amply adequate to provide interest and entertainment for the public, as well as opportunities for daily demonstrations by retailers of receiving sets.

Pedestrian-Operated Traffic Signals.

AN experimental scheme for the erection of pedestrian-operated traffic signals in Chiswick High-road has been approved by the Minister of Transport, and a grant from the Road Fund is to be made, which will permit the work to be put in hand at once. The system has been evolved in order to mitigate the danger of serious accidents, which have been frequent in this road during past months. All that pedestrians need do to ensure a safe passage across a road is to press a push button, which sets the signals against vehicular traffic. The selected positions for the new traffic signals are at the junctions of Chiswick High-road with Acton-lane and Goldhawk-road. The vehicle-operated signals now in use at Acton-lane will be modified and on the London side of the junction special signal lights will free pedestrians, and push buttons will be fitted to the posts. The signals will work in the normal way until a pedestrian presses the button, when the traffic in the main road will be stopped and the traffic on the side road will not be released until a pedestrian has had time to cross. During this "safety period" the pedestrian signals will show the words "Cross Now" in white letters on a black ground and at all other times they will show the words "Don't Cross" in red letters. The junction of Goldhawk-road and Chiswick High-road is a particularly dangerous one, on account of the heavy volume of traffic including tramcars, which, turning out of Goldhawk-road, passes over the pedestrian crossing on the Chiswick side of the junction. At this crossing push buttons with special pedestrian signals will be provided across each of the three arms of the junction. They will operate in a similar way to those at Acton lane. Owing to the heavy traffic at this point, the "safety period" will come into operation automatically during the busier times of the day, and it will not be necessary to operate the push buttons except when the traffic is very light. Vehicle-operated traffic signals are also being erected at the junctions of Chiswick High-road with Duke's-avenue, Chiswick-lane and Turnham Green-terrace. At Duke's-avenue, where the side road traffic is very small, the signals will be adjusted to stop the main road traffic for walkers at frequent intervals, although there may be no traffic passing over the detector pads in the side roads.

A Proposed Scottish Gas Grid.

A FURTHER step towards the supply of coke oven gas to gasworks and industrial undertakings was taken in Glasgow last week when on Wednesday representatives of Scottish coke oven gas producers and a committee appointed by the National Gas Council (Scotland) met to consider the supply of coke oven gas to gasworks and the conditions and terms upon which gas could be supplied and taken. Among the coke firms represented were:—Wm. Baird and Co., Ltd., Wm. Dixon, Ltd., Jas. Nimmo and Co., Ltd., Plean Colliery Company, Ltd., and Alloa Coal Company, Ltd.; while the Gas Council for Scotland was represented by Mr. Jas. Jamieson (Edinburgh), Mr. George Braidwood (Coatbridge), Mr. A. S. Nisbet (Paisley), Mr. R. D. Keillor (Greenock), and Mr. J. W. Napier (Alloa). Sir Wm. E. Whyte, Chairman of the Gas Council, was unavoidably absent. Mr Napier said that the great increase in the quantity of coke oven gas taken by gas undertakings during recent years indicated that coke oven gas supply was a sound, practical and commercial proposition. He instanced the examples of Sheffield, Rotherham, and Middlesbrough gas undertakings, and said that among the important factors were an uninterrupted supply, regularity in quality, and above all a mutually satisfactory price. The Gas Council, Mr. Napier said, was prepared to formulate a standard set of conditions for coke oven gas supply to be accepted by both parties, and it would render any influence and assistance necessary to carry proposals to a successful issue. For the coke oven owners, Mr. A. K. McCosh, of William Baird and Co., Ltd., welcomed the opportunity of discussing the matter with gas supply interests. At present, he said, the available quantity of coke oven gas was comparatively small, but in view of the new plants contemplated the surplus gas would amount to probably 10,000,000 cubic feet daily. After considerable discussion it was agreed by both parties to continue negotiations, and that a further meeting should be held.

The New Russian Orders.

LAST week it was officially announced by Arcos Ltd. that negotiations had been successfully completed for placing in this country larger orders for machinery and engineering supplies for shipment to Russia. The contracts, which have been placed on a cash basis for delivery within three to twelve months, amount to over a million pounds, and they are well distributed over the Midlands, the North, and Scotland. One of the principal orders is for close upon half-a-million pounds worth of complete sets of railway wheels, axles, and tires for Russian railway use, to be delivered in six months. In completing this contract some thirteen works will be employed, and about 30,000 tons of British steel used. Another large order is for 25,000 tons of special steels, which will be made in Sheffield and Scotland and other metallurgical centres, while manufacturers of non-ferrous metal products have received orders for some £300,000 of products for shipment to Russia. An order of unusual interest, since it is the first of its kind, is the placing of a large contract for paper-making machinery, which is required by the paper-making industry of the Soviet Union. In addition to the orders above mentioned, large purchases have also been made in the British market for goods for re-export to Russia, these being mainly from the British Colonies and Dominions.

The Decline in Coal Consumption.

IN the course of his presidential address to the Institution of Mining Engineers, which was delivered on Friday, February 1st, Mr. Laurence Holland, in surveying conditions in the mining industry, said that if the figures for home consumption were examined it would be found that in 1920, with a population of 42,388,000, there was available for home consumption a tonnage of 180,720,000. In 1933 the figure for home consumption was 148,370,000 tons, and the corresponding population figure was 44,900,000. Thus there was a decline of over thirty-two million tons in the consumption, despite a population increase of about two and a-half millions and the erection of a large number of new houses requiring lighting and heating in some form or other. How much of this reduction, Mr. Holland asked, could be laid at the door of depression? In 1920 there were about 500,000 unemployed in the country, against about 2,000,000 in 1933. Though out of work, they still had to buy coal, and coal and coal products were used in all the services by which they lived. If, therefore, a further consumption of 10 tons each, when replaced in employment, was allowed, that would account only for about fifteen million tons, leaving twenty-five million tons reduction in consumption to be placed to the account of increasing efficiency in all branches of fuel operation and power and heat supply. There had, he pointed out, been declines in the fuel used by the electricity generating industry, and the gas industry, mainly on account of improvements in efficiency, and such declines would continue. Now that the electricity industry was on its feet it was, Mr. Holland suggested, well able to pay a reasonable price for its fuel and so benefit the coal industry. It could not, he thought, be hoped for many years at any rate, to regain the position held by the industry in 1913. As far as home consumption was concerned, trade was definitely improving, but fresh outlets must be found for the use of coal. One of the most hopeful avenues to explore was the one by which coal and coal products were found to replace imported fuels and their products.

New Shipbuilding Orders.

AT the beginning of the month the Anglo-Saxon Petroleum Company, Ltd., placed orders for five oil tankers, to be built on the Clyde and Tyne. These contracts were awarded, we learn, in the face of keen competition with Continental shipbuilders. Two ships, each of 9250 tons deadweight carrying capacity, are to be built by Harland and Wolff, Ltd., at Govan, while one ship of 12,100 tons deadweight carrying capacity will be constructed by the Blythswood Shipbuilding Company, Ltd., of Scotstoun. Two further 9250-ton tankers will be constructed by Swan, Hunter and Wigham Richardson, Ltd., of Wallsend-on-Tyne. The propelling machinery for all the ships will comprise supercharged oil engines, with exhaust gas boilers. Further orders placed recently on the North-East Coast include a 9300-ton, 450ft. cargo steamer for Sir R. Ropner and Co., Ltd., which will be built by William Gray and Co., Ltd., of West Hartlepool, and engined by the Central Marine Engine Works with Parsons type double-reduction geared turbines. The Goole Shipbuilding and Repairing Company, Ltd., is to build a motor vessel of 400 tons deadweight carrying capacity for British overseas trade; while at Birkenhead Cammell Laird and Co., Ltd., have received an order for a 10,670 gross ton motor vessel for the Blue Star Line, Ltd., which will be equipped with Sulzer oil engines. Orders for Sulzer oil engines have also been placed for small oil tankers for Argentine and Dutch owners.

The Jubilee of the Central College.

ON Monday last the City and Guilds College, or the "Central," as it used to be known, celebrated its jubilee in the College buildings in South Kensington, and some two thousand old students and their ladies congregated to do honour to the occasion. They were received by Lord Linlithgow, the Chairman of the Governing Body of the Imperial College of Science and Technology, and by Mr. W. T. Prideaux, the Chairman of the Delagacy of the City and Guilds College. In view of the facts that practically all English-speaking engineers must know the fame of the "Central," and that we publish elsewhere in this issue an article on its history, it would be redundant to say much here. Neither is it necessary to enlarge upon the flattering remarks of the hosts, the quizzing of Dr. Armstrong, and the thanks of Mr. H. T. Tizard. The opportunity was taken to confer honorary fellowships of the Institute on three of its past professors—Armstrong, Dalby, and Mather—as a token of the great services they had rendered to the College. For the evening the atmosphere of the building was wholly changed, and from hurrying serious students the inmates passed to ladies in evening dress and men in bright official robes, many exploring the novelties of a building they knew years ago, but had not visited since. It was a happy evening, and the occasion of the meeting of many old friends.

An Inland Water Survey.

REFERENCES have already been made in these columns to the proposal of the Minister of Health and the Secretary of State for Scotland that an Advisory Committee should be formed to deal with an inland water survey of Great Britain, and to report annually on the measures already taken towards this end and on the further measures required. On Wednesday, February 6th, the names of the members of the Committee were officially announced. They are: Colonel Sir Henry Lyons (Chairman), Sir Charles Bird, Professor W. S. Boulton, Mr. G. Dallas, Mr. G. J. Griffiths, Lieut.-Colonel F. Hibbert, Sir Clement Hindley, Mr. S. R. Hobday, Mr. W. A. Millar, Mr. D. Paul, and Mr. B. Verity. The Secretary to the Committee is Mr. I. F. Armer, and any communications relating to the work of the Committee should be addressed to him at the Ministry of Health, Whitehall, S.W.1. In constituting the Committee the object in view has been, we learn, not to appoint representatives of organisations or interests, but to obtain a body of men of different classes of experience serviceable for the work to be undertaken. The geological qualifications of Sir Henry Lyons and Professor Boulton are outstanding, and Sir Clement Hindley is a member of Council of the Institution of Civil Engineers, and a member of the Advisory Council of the Department of Scientific and Industrial Research.

A London Electricity Merger.

IN November last, a company under the title of the Central London Electricity Distribution Committee (1934), Ltd., was formed to improve the organisation of the distribution and supply of electrical energy in the County of London and elsewhere, and at the time it was announced that six electricity companies had signified their adhesion to this co-ordination project. A further step has now been taken by the registration, announced in the daily register of Jordan and Sons, of London Associated Electricity Undertakings, Ltd., the object of which company is to acquire not less than 90 per cent. of the issued share capitals of the Brompton and Kensington Electricity Supply Company, Ltd., Charing Cross Electricity Supply Company, Ltd., Chelsea Electricity Supply Company, Ltd., Kensington and Knightsbridge Electric Lighting Company, Ltd., St. James and Pall Mall Electric Light Company, Ltd., and the Westminster Electric Supply Corporation. The initial nominal capital of the new company is only £300 in £1 shares, and the issued share capitals of the six companies named above amounts to a total of £6,892,194.

The Development of Parsons Industrial Turbo Machinery.

No. V.

(*Continued from page 118, February 1st.*)

TURBO-BLOWER FOR SIR B. SAMUELSON AND CO.

THE first turbo-blower to be used for the supply of air to blast-furnaces was constructed, as will be remembered, for the Farnley Ironworks in 1902. This was a small machine, designed only for an output of 10,000 cubic feet of free air per minute at the very moderate pressure of 3 lb. per square inch. It was quickly followed by a turbo-blower for similar duties, but of much larger capacity, ordered by Sir B. Samuelson and Co., Ltd., in 1903 for their Newport Ironworks at Middlesbrough. This unit was required to deliver 21,000 cubic feet of free air per minute at a pressure of 10 lb. per square inch, when running at a speed of 3000 r.p.m. A photograph of it, taken after its erection in the works at Middlesbrough, is reproduced in Fig. 45, while a section through the turbine and compressor is given in Fig. 46.

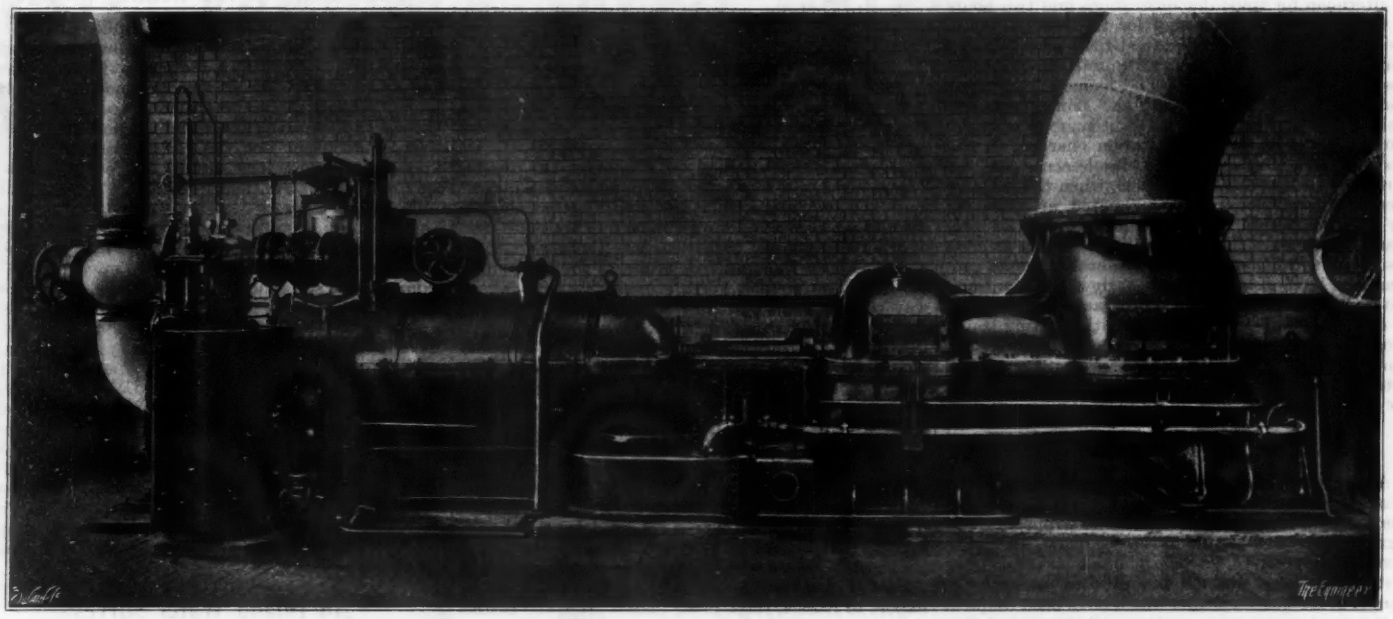


FIG. 45—21,000 CUBIC FOOT TURBO-BLOWER ERECTED AT SITE—1903

The turbine was designed to work with steam at 150 lb. per square inch and to exhaust against atmospheric pressure. It contained thirty-eight pairs of blade rows arranged in seven groups of increasing height, on three diameters of the spindle. Two centrifugal governors were driven by worm and bevel gearing from the turbine shaft, one controlling the speed by means of a double-beat valve with steam relay, the other operating the runaway valve in the event of overspeed. The turbine is of interest as providing one of the earliest examples of the use of a by-pass valve to increase the output of power. The steam coming from the stop valve entered the steam chest, which was placed above the turbine cylinder, and passed first through the runaway valve and then through the governor valve. A branch pipe below the governor valve enabled live steam to be led to the turbine between the first and second drum diameters, thus by-passing all the blading previous to this point. The admission of steam by this pipe was controlled by a hand-operated by-pass valve. Since the whole of the steam admitted in this way had first to enter through the runaway valve and the governor valve, the turbine was at all times under the control of the governors, whether the by-pass was in use or not. In the turbines in question the employment of the by-pass enabled the machine to be speeded up to 3600 r.p.m. This increase of speed raised the blast pressure to about 18 lb. per square inch, so that in the event of the furnace becoming choked it could easily be blown free.

The blower was of the single-flow type, with thirty-four pairs of blade rows. The blades, as in previous machines, were plano-convex in section, those on the rotor acting as impellers while the fixed blades merely re-directed the air into a longitudinal course. It will be noticed, by referring to Fig. 46, that the air flow through the blower was in the same direction as the steam flow through the turbine. Although this arrangement resulted in the end thrusts of the two rotors being opposed to each other, no advantage was taken of this fact to balance the set. The turbine and the blower were both balanced independently, the former by three dummy pistons and the latter by one. Each machine also had its own thrust block for the independent axial location of its rotor. The shafts were connected by two flexible claw couplings with a distance piece between them, in order to leave sufficient room between the cylinders for the turbine exhaust pipe and the air inlet pipe to the blower.

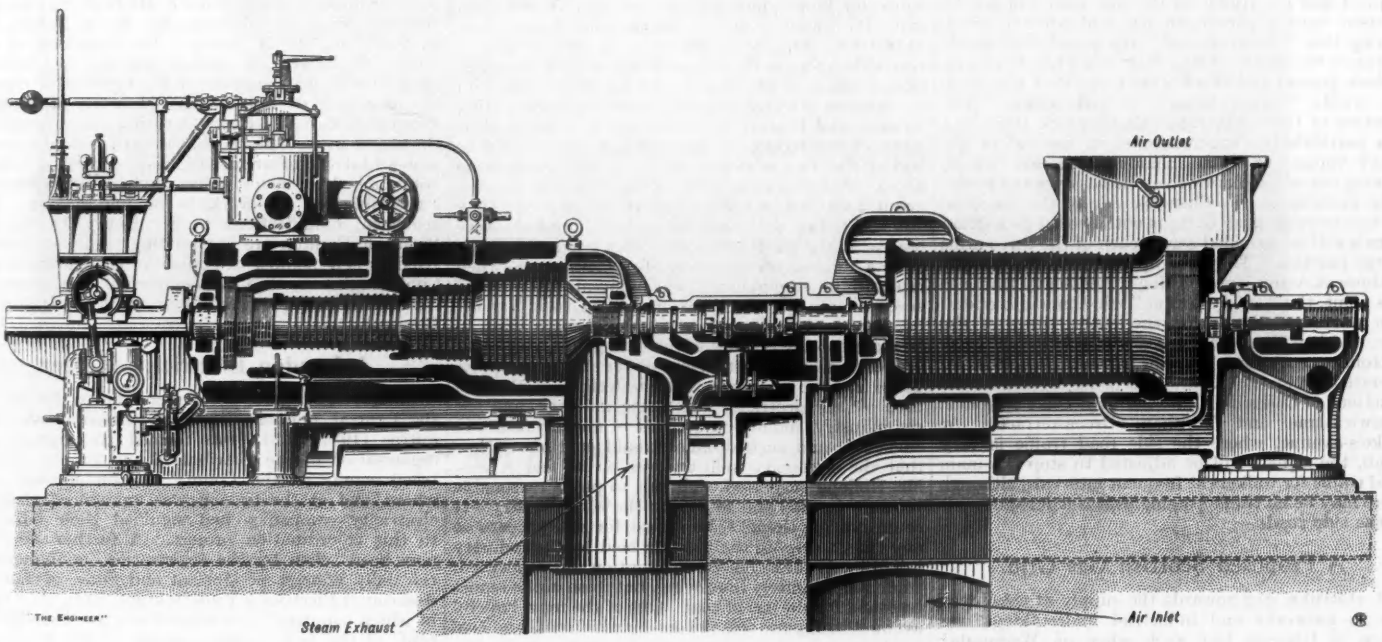


FIG. 46—SECTIONAL VIEW OF TURBO-BLOWER FOR SAMUELSON AND CO.

THE FIRST EXHAUST STEAM TURBINES.

The idea of employing a low-pressure turbine to make use of the exhaust steam from a reciprocating engine was patented by Sir Charles Parsons in 1894. Some years elapsed before the principle received practical application. The earliest example of such a combination of reciprocating and turbine machinery was provided by the 30-knot destroyer "Velox," launched in 1902 from the Tyneside yard of Hawthorn, Leslie and Co., Ltd., and purchased afterwards by the Admiralty. This installation, however, was not at all a typical one, for the reciprocating engines were of very small power compared with the main turbines and were only used for cruising speeds, when they exhausted into the turbines. They drove on two of the four shafts through claw couplings, and were disconnected when the vessel steamed at any speed over 12 or 13 knots.

No pure exhaust turbine was used on land until 1904, and even then its steam was not taken from a reciprocating engine. The machine in question was installed in the well-known brewery of A. Guinness, Sons and Co., Ltd., in Dublin, to develop power from the waste steam coming from the heating vats in the brewery. The steam, before being used in the vats, had already done work in a 250-kW turbine supplied by Messrs. Parsons in 1900. This turbine was arranged to exhaust at a gauge pressure of 11 lb. per square inch, and the steam being absolutely free from oil and other impurities after passing through the turbine, was passed directly into the vats for heating purposes. This procedure was entirely successful, but it was thought that the steam coming from the vats might still be profitably employed for the production of power, and Messrs. Parsons were therefore asked to supply machinery suitable for its utilisation.

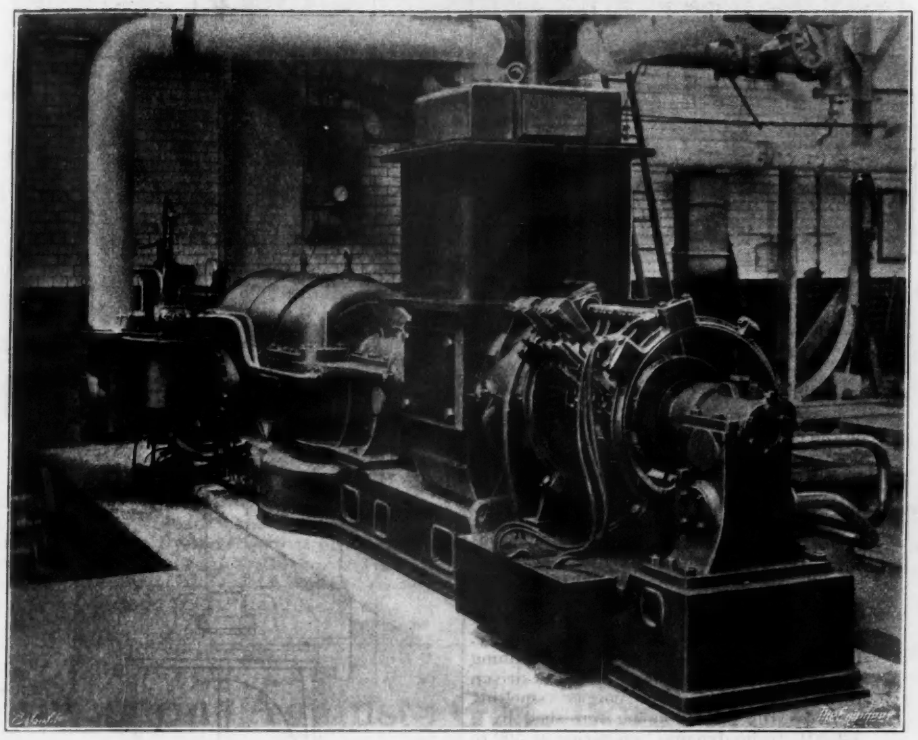


FIG. 47—250-KW EXHAUST STEAM TURBO-GENERATOR—1904

on a rotor diameter of 12·25in., and the final blades a height of 4in. on a rotor diameter of 17in. A comparison of Fig. 48 with the drawings of previous turbines will show a considerable improvement in the arrangement of some of the parts. The steam chest has been removed from its former position on the top of the turbine, and placed alongside the machine; the governor gear has also been moved to the lower side of the horizontal joint of the pedestal. As a consequence of these changes the turbine cover could be lifted off and the pedestal cap also removed without having first to dismantle the steam pipes and governor gear.

Details of the arrangement of the governor and levers are given in Fig. 50. The governor was driven from the end of the turbine shaft by worm gearing, and was entirely enclosed, another substantial improvement. The governor mechanism consisted

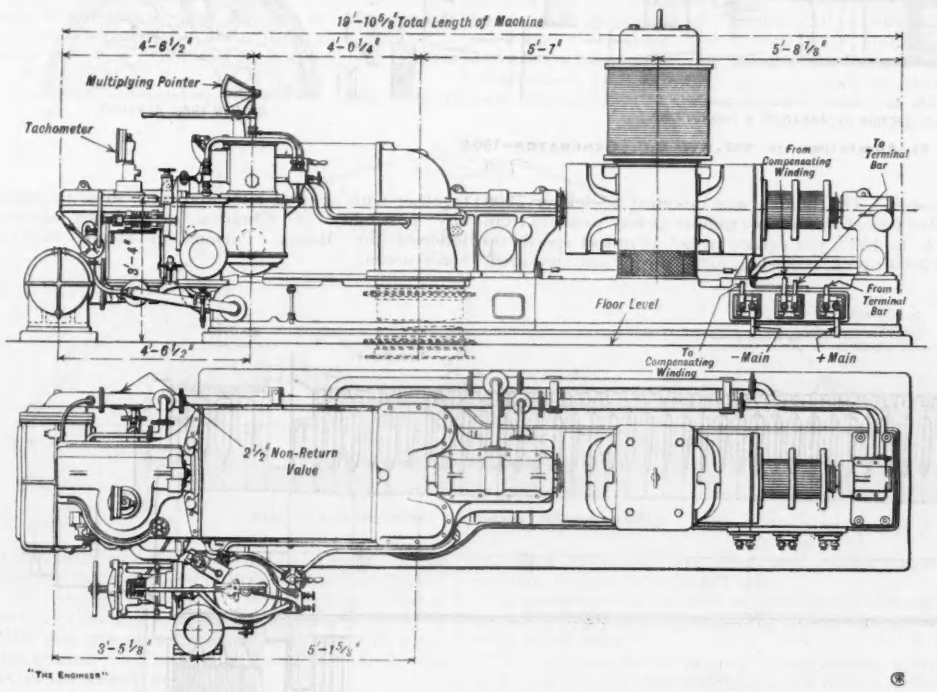


FIG. 48—PLAN AND ELEVATION OF EXHAUST STEAM TURBO-GENERATOR

The plant provided is illustrated in Figs. 47 and 48. It consisted of an exhaust steam turbine driving a 250-kW D.C. generator at 3000 r.p.m. and exhausting, of course, into a condenser. It will be noted that the power obtained from the steam after use in the vats was substantially equal to that obtained from it in the first place, so that the production of energy was doubled with no greater consumption of fuel. The turbine supplied contained twenty-seven pairs of blade rows, the first blades having a height of 1·5in. of the usual weights and springs acting on a sleeve which was connected through a train of levers to the steam relay plunger of the main throttle valve. Hand adjustment of the speed was provided for by a regulating spring, the tension of which was applied to the governor sleeve by an auxiliary lever, seen above the main governor lever in Fig. 50. Governing was not effected by the "gust" system, which was customary with steam relays, but by the simple throttling of the steam. A section through the main throttle valve, showing the relay mechanism, is given in Fig. 49. Steam was admitted to the chamber above the double-beat throttle valve through the combined runaway and stop valve seen on the left. From this chamber a small quantity of steam passed constantly to the underside of the relay piston by way of the drilled port and needle valve shown. The pressure of this steam raised the piston against the action of the spring above it and consequently opened the throttle valve. The relay plunger at the side of the cylinder controlled the escape of steam from beneath the piston. It was so adjusted that a small quantity of steam was always escaping from the cylinder. If the speed of the turbine increased the plunger was raised by the action of the governor, thus allowing more steam to escape, and so reducing the pressure under the piston. The latter was then forced down by the spring and the throttle valve was consequently closed. The amount of the opening of the throttle valve at any time was indicated by a pointer on a quadrant at the top of the steam chest.

The combined runaway and stop valve is shown partly in section in Fig. 53. The rotation of the hand wheel caused the movement of a sliding crosshead A, guided by the pillars at each side. A lever B, pivoted to the crosshead at the point C, is shown in the illustration lying in its normal position parallel to the axis of the valve. The lowermost end of this lever was connected by links to the runaway governor, while the upper end carried a handle for tripping the valve in emergency, or for resetting it after it had tripped. To the crosshead were also pivoted

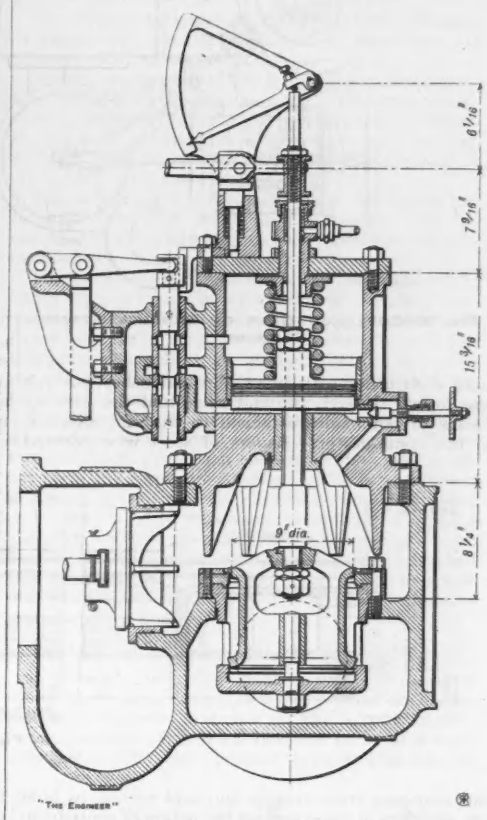


FIG. 49—MAIN THROTTLE VALVE OF EXHAUST STEAM TURBINE

two levers D, D, the upper ends of which were linked to either side of the centre of the lever B. The upper end of the spindle to which the valve itself was attached, was held in a crosshead E, also guided by the pillars. Between the two crossheads A and E, was a powerful spring tending to force them apart. They were normally held together by hooks on the levers D, D attached to the crosshead A, so that both crossheads would move simultaneously when the hand wheel was turned, and the valve would be opened or closed in the ordinary manner. If, however, while the valve was open, the lower end of the lever B was moved to the left by the operation of the runaway governor, or the upper end of the same lever was moved to the right by the operator, the hooked levers were disengaged from the lower crosshead and the valve was instantly closed by the action of the spring. To prevent shocks to the valve and seating due to the sudden closing of the valve, the lower side of the crosshead was provided with annular ribs which entered corresponding grooves in the cover of the valve chest and produced a cushioning effect.

The dynamo was a bipolar machine with shunt-wound magnets of the horse-shoe type, the poles of which were slotted to receive a compensating winding to neutralise the armature reaction. The machine had a smooth-core armature, as illustrated in Fig. 51. The armature windings were laid over the core, and their end turns spaced by means of beech-wood driving pegs, driven into the brass end rings supporting the turns. These end rings were of spider form to give the ventilating air access to

the longitudinal holes through the core. They were each built up of three sections, and were separated from the core by a series of brass plates insulated from each other with presspahn and asbestos. Air was drawn through the end rings and the core by means of fan blades attached to the end adjacent to the commutator. Layers of steel wire covered the armature from end to end and served to hold the windings in place against the action of centrifugal force. Sheet brass guards fixed to the magnet poles enclosed the projecting ends of the armature.

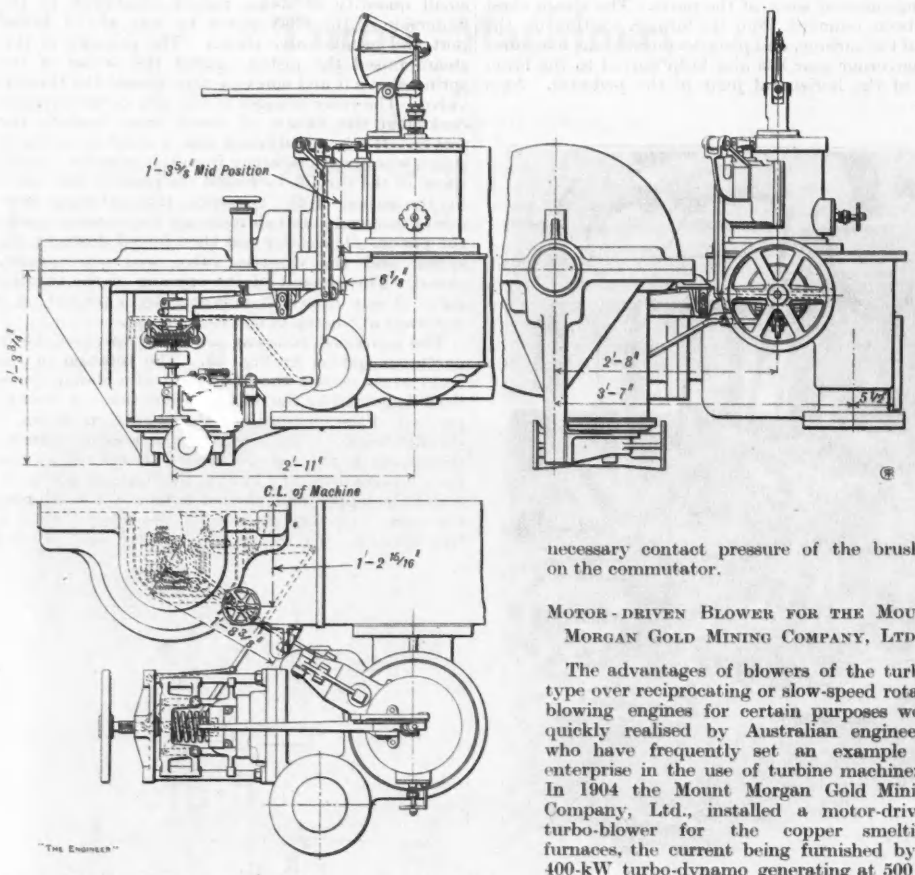


FIG. 50—GOVERNOR GEAR OF EXHAUST STEAM TURBINE

with the respective coils. The brushes were of brass wire, and were held in sockets of the same metal, which were weighted at their ends to supply the necessary contact pressure of the brushes on the commutator.

MOTOR-DRIVEN BLOWER FOR THE MOUNT MORGAN GOLD MINING COMPANY, LTD.

The advantages of blowers of the turbo-type over reciprocating or slow-speed rotary blowing engines for certain purposes were quickly realised by Australian engineers, who have frequently set an example of enterprise in the use of turbine machinery. In 1904 the Mount Morgan Gold Mining Company, Ltd., installed a motor-driven turbo-blower for the copper smelting furnaces, the current being furnished by a 400-kW turbo-dynamo generating at 500 to 555 volts, also supplied by Messrs. Parsons. The motor for driving the blower was of similar construction to the 250 kW dynamo constructed for A. Guinness, Sons and Co. in the same year, and already described in some detail. Like the dynamo, it was provided with a compensating winding to enable it to run sparklessly at all loads with fixed brushes. The blower was designed to deliver 3000 cubic feet of free air per minute at any pressure from 8 lb. to 15 lb. per square inch. It ran at speeds up to 3600 r.p.m., according to the air pressure required.

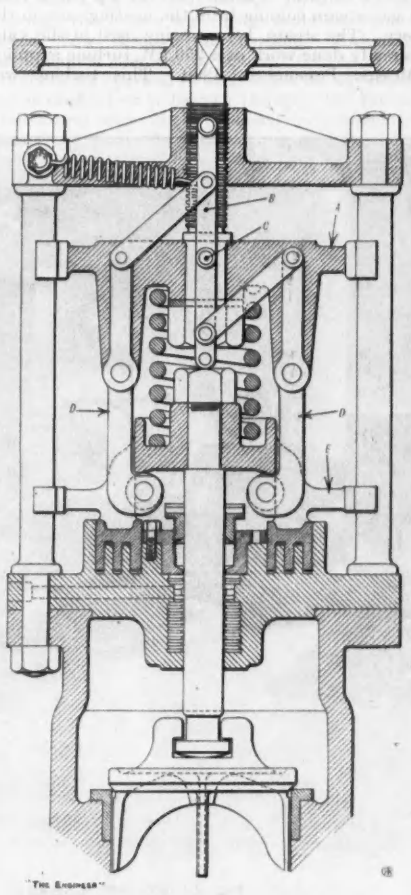


FIG. 53—RUNAWAY AND STOP VALVE

Forty-eight of these discs carried each a single row of moving blades, and at each end of the set was a solid disc grooved to take the balancing weights. The hubs of all these discs were in close contact. The remaining four discs constituted the dummy piston to take the end thrust of the air. These, being subject to greater pressure, were butted together both at their hubs and rims, so as to avoid any possibility of vibration, a practice always followed by Messrs. Parsons in steam turbine construction.

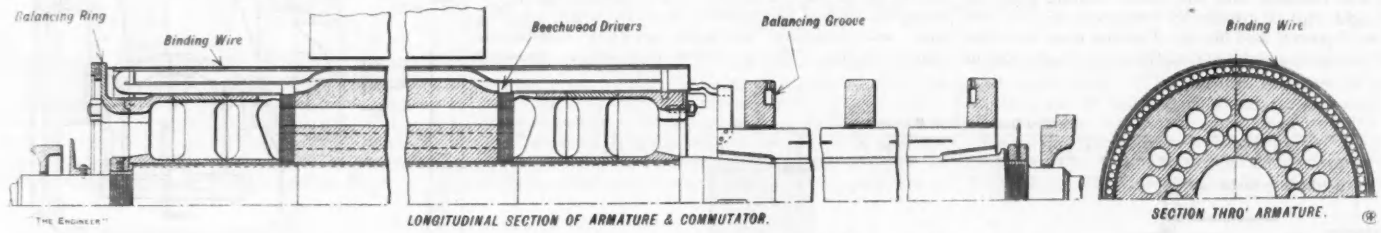


FIG. 51—ARMATURE OF 250-KW D.C. GENERATOR—1904

The commutator bars were insulated from each other with mica and were held together by heavy steel rings shrunk over mica bushings round the commutator. The commutator was mounted on brass cones, and flexible copper leads connected the risers

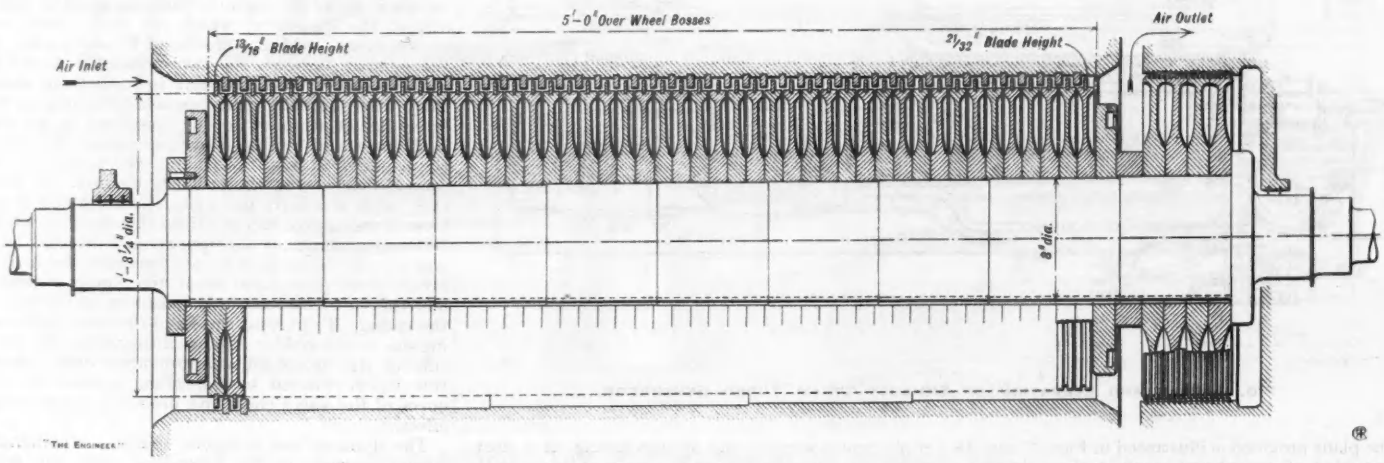


FIG. 52—DETAILS OF SHAFT AND BLADING OF BLOWER FOR MOUNT MORGAN GOLD MINING COMPANY—1904

The essential features of the blower are shown in Fig. 52. Instead of the solid rotor used in previous machines of the kind, a built-up construction was employed, consisting of a stout central shaft on which were shrunk and keyed altogether fifty-two discs.

The blades themselves were of the plano-convex cross section used in previous blowers and compressors, the running blades being set at an angle to act as impellers, and the stationary blades fixed with their plane faces in a fore and aft direction to restore

the longitudinal motion of the air. The forty-eight rows of running blades were on a uniform wheel diameter of 20·25in., their heights diminishing from 0·812in. to 0·656in. in four steps along the length of the rotor.

developed by Messrs. Parsons, and by the end of 1911 four additional machines of the new type, together with two more turbo-dynamos, had been installed. The three original blowers were also replaced by centrifugal blowers, which were coupled

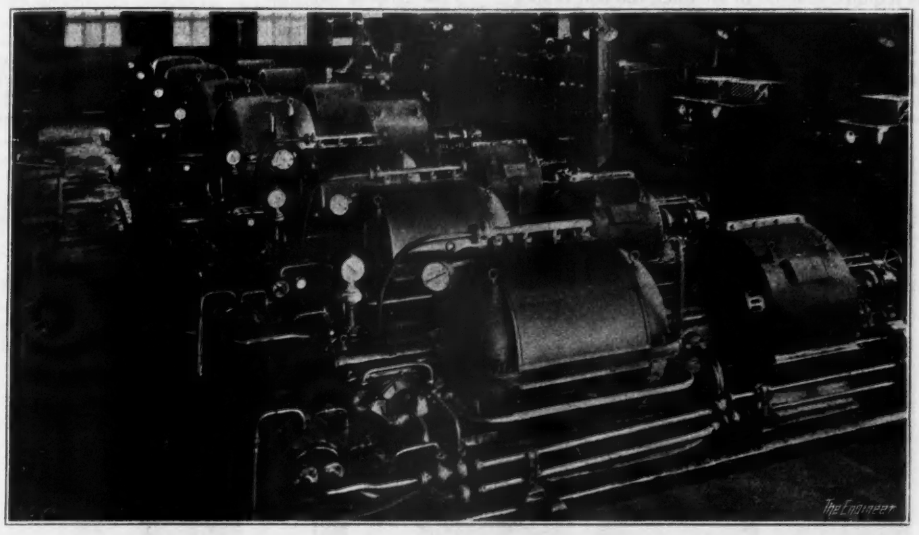


FIG. 54—MOTOR-DRIVEN BLOWERS OF MOUNT MORGAN GOLD MINING COMPANY—1911

The machine was so satisfactory that two more of exactly the same capacity and type were installed shortly afterwards. By the time that further extensions of the plant called for still greater blowing capacity, the centrifugal type of blower had been to the existing motors. The design of the centrifugal blowers will be described in due course.

Fig. 54 shows the seven motor-driven blowers in the power-house in Australia.

(To be continued.)

Protection Against Gas Bombardment.*

By M. DU-PLAT-TAYLOR, M. Inst. C.E.

THE use of toxic and asphyxiating gases in warfare is by no means new.

In 1275 an Arab writer Hassan Abramanach described the fabrication of poisonous gas from arsenic and opium ; and in 1650 Glauber, the German chemist, prepared a formula for the manufacture of hand grenades containing a mixture of turpentine (probably rosin), nitric acid, and gunpowder, designed to suffocate the enemy. Sulphur fumes were also employed from time to time for this purpose, and Lord Dundonald in 1855 made a proposal for the use of charcoal and sulphur for filling shells for use in the siege of Sebastopol ; but this was not approved of by Lord Palmerston. These facts were not made public until the publication of the Panmure Papers in 1908.

No further attempts appear to have been made to develop this form of warfare until the great German gas offensive was devised in 1915 by Professor Nernst, of the Berlin University, and Professor Haber, Director of the Emperor William Institute at Dahlem.

The first gas attack was released on April 22nd, 1915, against the Ypres Salient, and cost the lives of 5000 of the Allied troops.

To illustrate the concentration of such attacks, the Austrian gas attack of June 29th, 1916, at St. Michele del Carso may be described. In this attack 6000 cylinders of liquid chlorine, each of 110 lb. weight, were employed on a front of 6 kiloms., or one cylinder per metre of front. The valves of all the 6000 cylinders were opened simultaneously in a favourable wind, and the resulting heavy cloud of chlorine gas descending upon the Italian trenches destroyed 8000 men.

Since 1918 gas warfare has been perfected, some hundreds of gases having been investigated, and the immense improvement in air transport has rendered possible the discharge over enemy cities of quantities of gas immensely larger than those possible during the war.

We have it on the authority of Marshal Pétain that, in January, 1934, Germany possessed 375 aircraft, each capable of carrying a load of 1 metric ton of gas bombs to a distance of 500 kiloms. (310 miles) and returning to its base, and thirty larger machines capable together of carrying 50 tons to a distance of 1000 kiloms. (621 miles). Italy possessed at that time 420 machines capable together of carrying 300 tons for a distance of 310 miles, and enough larger machines to carry 50 tons 621 miles.

The distance from the nearest point on the German frontier to Paris is 200 miles as the crow flies, and to London 350 miles.

The total weight of projectiles discharged upon Paris by aerial and other bombardments in the eleven months ended November, 1918, was 11 tons, or 1 ton per month ; whereas it would now be possible to discharge over 50 tons in one day, assuming that only half the available machines were used and only one-quarter of the invading aeroplanes escaped destruction on the way.

There is also the question of land bombardment. On March 23rd, 1918, Paris experienced for the first time a bombardment with high-explosive shells, which had been fired from a gun mounted in the forest of St. Gobain on the German front at the unprecedented range of 75 miles. These shells were 8·28in. in diameter, weighing 330 lb., and fitted with long hollow ogival heads. It has been calculated that the muzzle velocity of the gun was 5000 foot-seconds, or nearly 1 mile per second, and that the velocity of arrival of the shell was 2626ft. per second. The velocity of arrival of the shell being over double that of sound in air, it was impossible to hear it coming. In the course of its flight (see Fig. 1) the shell passed into the stratosphere, the highest point of its trajectory being 24 miles above the earth's surface, or four times the height of Mount Everest.

There is no reason, other than difficulties of manufacture, why guns should not be constructed for a much higher muzzle velocity even than this, to throw shells to a much greater distance with considerable accuracy.

Three-quarters or more of the trajectory would be practically in vacuo, where no disturbing influences would deflect the path of the shell.

There is, however, a great disparity of cost between that of the use of such guns and of the use of aircraft for conveying like quantities of gases, in favour of the aeroplane.

It is therefore likely that guns will only be employed on account of the element of surprise, and that the greater part of gas bombardments in future will be carried out by the medium of air transport, probably with machines constructed for purposes of civil aviation.

War gases may be divided into—

(1) " Fugitive " gases, which are gaseous at atmospheric pressure and at ordinary temperatures, such as chlorine, phosgene, carbon monoxide, and nitrous gases.

(2) Persistent gases, such as Yperite (mustard gas), Lewisite, and arsenical dust clouds, which are six times as toxic as phosgene.

The action of mustard gas is on the skin, and therefore no mask is effective against it. The only protection is a completely protective airtight suit of rubber-impregnated clothing in combination with an air-filtering mask or oxygen regenerative apparatus, or else resort to an airtight shelter.

The other gases mentioned above act upon the throat, nose, and lungs, and protection can be obtained by filter masks or oxygen regenerative apparatus alone.

The latest form of gas mask is a charcoal filter, either in combination with various chemical substances or alone. The objection to a gas mask of this nature is that in some strong concentrations of gas there is not enough oxygen to maintain life, and when the chemical substances of the gas are filtered out the wearer would still die of suffocation.

Portable oxygen inhalers have therefore been adopted, of which there are many patterns. These form complete protection against all the gases which act upon the respiratory system. The type adopted in France is known as the Oxylithe-Lemoine system, and consists of a knapsack containing a mixing chamber which is provided with a connection for an oxygen cartridge or sparklet, which can be attached to the apparatus by the wearer and replaced by a new one when it is exhausted. The cartridge contains granulated oxylith.

COLLECTIVE SHELTERS AGAINST GAS ATTACK.

In principle these shelters are a protection against the three dangers, namely, the explosion of shell, fire, and asphyxiation. A shelter for the purpose of protection against (1) and (2) requires to be at a considerable depth below ground level, and should be provided with a roof of considerable thickness of reinforced concrete.

With regard to the third danger, that of asphyxiation, the shelter must be absolutely air-tight.

Experiments have been made with various types of door sealing apparatus, and have shown that there is no difficulty in meeting this requirement, so far as the entrance and exit to the shelter is concerned. The most effective system is that which depends upon a pneumatic bolster joint, which can be inflated when the door is closed.

This type of joint is shown in Fig. 2. The left-hand view shows a section of the joint with the door open, *a* and *b* representing the fixed part of the door or jamb, of which *b* is that portion which is on the opening side and is cut away to allow the door itself to close or open ; *c* is the edge of the door which forms

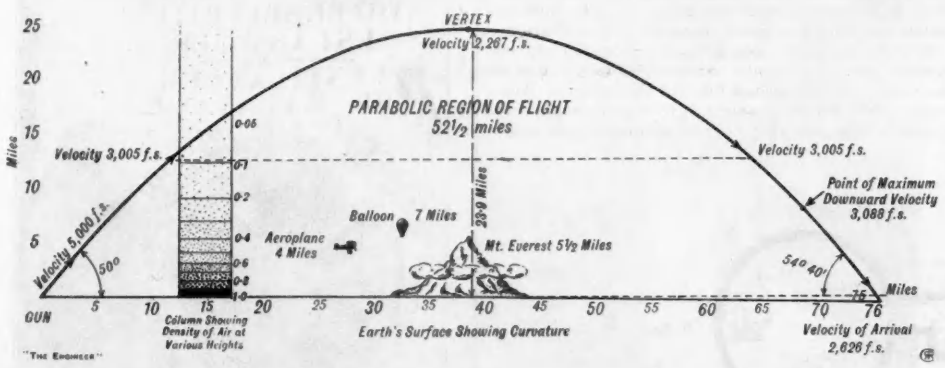


FIG. 1—TRAJECTORY OF LONG RANGE SHELL

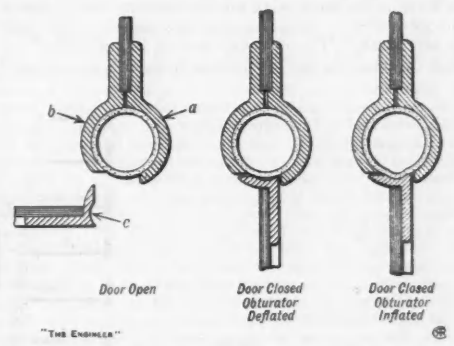


FIG. 2—PNEUMATIC BOLSTER DOOR JOINT

* Based upon the papers on " The Means of Defence Against Attacks by War Gas " and " Defence by Isolating Chambers and Shelters," by Monsieur George F. Jaubert ; and " Air Filtering Appliances in Gas Warfare," by Monsieur Louis Bergé, read before the Société des Ingénieurs Civils de France, 1934

the air-tight joint. The next view shows the door closed with the joint not inflated, and the last the door in the same position with the joint inflated.

The bulge produced by the rubber tube which projects into the recessed part of the door also keeps the door closed unless considerable force is exercised.

In other systems the air-tightness is assured by compression from the outside of some jointing material, which may be rubber, copper, tallowed plait, flax, &c. This compression is effected by some mechanical method, which must be so arranged that it can be operated rapidly.

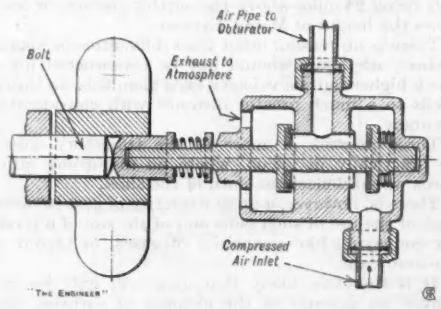


FIG. 3—DOOR-LOCK VALVES

With the pneumatic joint an arrangement, shown in Fig. 3, can be provided, by means of which the inflation is instantaneously and automatically effected by the movement of the bolt of the door lock. The opening and closing is done in the same manner as in an ordinary door and the turning of the bolt handle for locking opens a valve and instantaneously inflates the obturator by the admission of compressed air from an air bottle. The opposite action of unbolting the door disconnects the obturator from the compressed air supply and opens it to the atmosphere, so that it immediately becomes deflated.

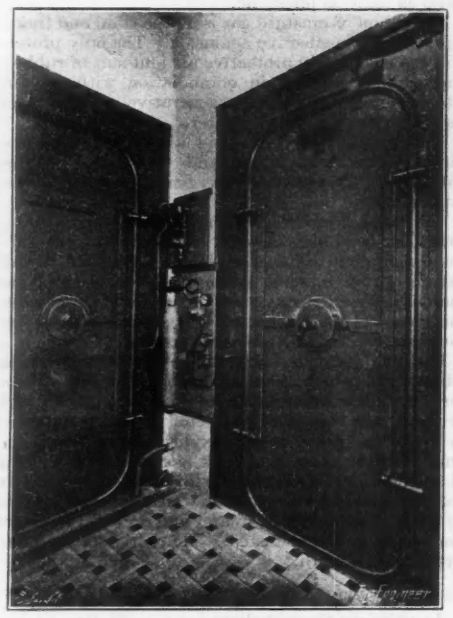


FIG. 4—AIR-TIGHT DOORS

In the event of the failure of the compressed air supply provision is made whereby the obturator can be inflated by a few strokes of an air pump.

Two doors of this type (the Payen-Gip system) installed in a gas shelter in the sub-basement of one of the large Government offices in Paris are shown in Fig. 4. A small bottle of compressed air is seen between the two doors mounted on a board on the wall.

As only a small quantity of compressed air is required for the necessary amount of inflation of the obturator, it might easily be arranged for the locking bolt to operate a piston or plunger so as to furnish the required amount of air when the bolt is shot.

AIR SUPPLY AND VENTILATION OF SHELTERS.

There are two methods of assuring the proper ventilation of shelters: (1) the open cycle system, by which air drawn from the outside of the shelter is passed through large fixed filters before delivery into the shelter and the vitiated air is passed back to the atmosphere by fans; and (2) the closed cycle system, by which the air in the shelter is filtered to remove waste products and regenerated by the use of oxygen in cylinders or oxylith regenerators.

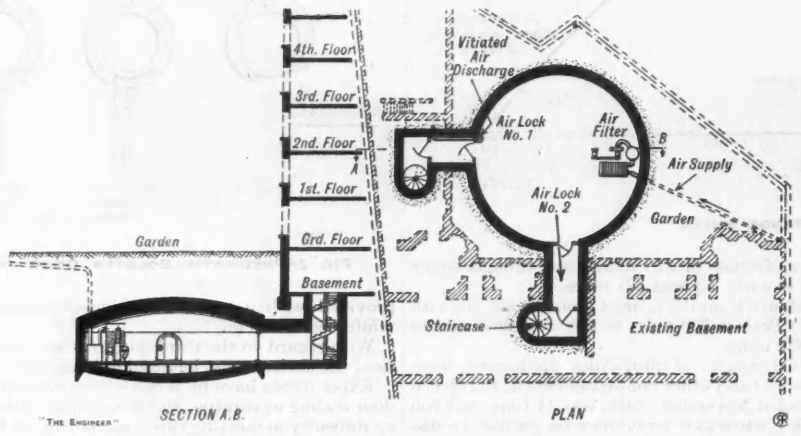


FIG. 5—UNDERGROUND SHELTER

The second system is that employed in submarines.

Approximately 130 grammes of oxygen is required for each person per hour; and, as a rough test for air in an enclosed space, a lighted candle is extinguished in an atmosphere containing less than 16·2 per cent. of oxygen, and a match cannot be lit in an atmosphere containing less than 17·5 per cent. of oxygen.

The Open Cycle System.—This consists in the simple filtration of the exterior air drawn from as great a height as possible above ground level by means of an electric fan (and in case of failure of the current by a pedal-operated fan). This exterior air is first of all filtered in an anti-arsenical filter, the object of which is to retain all the gases which may exist in corpuscular form in the air drawn in. The air is then passed through a carbon filter in which all the heavy gases, chlorine, phosgene, &c., are arrested. The only gas which can wholly or partly escape this purification is extremely light gas, such as carbonic oxide or hydrocyanide gas. A carbonic oxide detector is placed on the outside of the second filter of the system. Automatic valves are so arranged as to enable the filters to be quickly put out of the circuit and to seal the intake of air hermetically. Consequently, if the detector indicates the presence in the filtered air of toxic acid, or if the manometer in the intake indicates an unexpected obstruction in the air supply pipe which might be caused, for instance, by the destruction of the outer part of the intake pipe by a shell, it must be possible to change over instantly to the closed cycle air system.

The Closed Cycle System.—There are several types of apparatus for closed cycle working. The used air is decarbonised by alkaline solutions or anhydrous products. The complement of oxygen is made up by providing this in a compressed form in steel cylinders or by generating it from oxylith (alkaline peroxide). A kilogramme of oxylith produces approximately 150 litres of oxygen.

DESIGN OF SHELTERS.

As already stated, the shelters consist of underground chambers completely protected from bombardment, if possible, but in any case air-tight, and they must therefore be provided with air-tight doors. In addition, it is better that there should be a slightly higher air pressure within the shelters, which would tend to prevent any exterior gas from penetrating, either by accidental cracks or imperfections in the obturator.

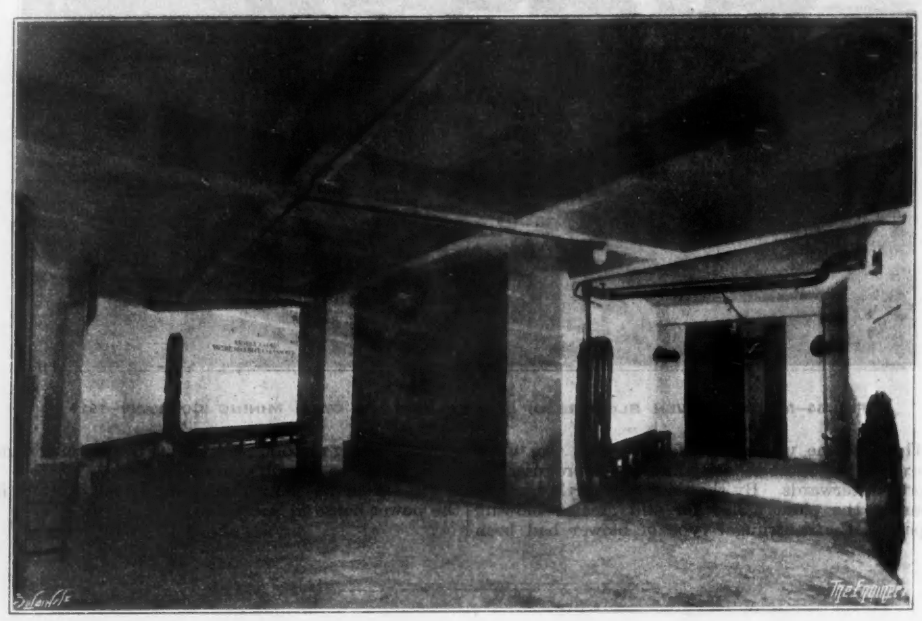


FIG. 6—UNDERGROUND SHELTER UNDER A GOVERNMENT BUILDING

Air-tightness of masonry shelters is difficult to ensure, and it is in this respect that a metallic chamber is a considerable advantage. Nevertheless, it is almost impossible to provide a metallic chamber to hold more than a hundred persons. For larger numbers it is, therefore, necessary to adopt some other form of construction.

Reinforced concrete appears to be the most satisfactory from the point of view that it can be further rendered impervious to gas by a coating of tar or some form of paint. It is necessary to take steps to prevent the sudden irruption of a crowd in an underground shelter as this might involve a cloud of gas entering. To prevent this, shelters are provided with air locks so arranged that the inner and outer doors cannot be opened at the same time.

FIG. 7—FAN FOR CLEARING OUTSIDE GAS

The position of the staircase leading down to the shelter requires to be carefully considered, both from the point of view of admitting gas and from the point of view of the entrance being demolished or blocked by bombardment, so permanently

imprisoning those in the shelter. It is for this reason considered better that the entrance should be from a basement or sub-basement of some building, and that there should be two entrances as far apart as possible to every large shelter.

As it may be necessary in a continuous bombardment to provide means for a prolonged stay in the shelter, chairs, tables, hammocks for sleeping, electric cooking arrangements for warming up previously prepared food, water supply and water closets must be provided.

The evacuation of soiled water is arranged by means of a force pump, by which it is pumped into the sewers, usually at a higher level than the underground shelter.

To determine the size of shelter, the volume required per person is obtained by the following formula :—

$$T = \frac{V}{N} \times \frac{3}{4}$$

T being the time in hours during which N occupants can remain in a shelter of volume V cubic metres without the necessity of eliminating the carbonic acid.

Resolving this equation, we get :

$$V = \frac{4\,N\,T}{3}$$

and if N and T are unity, we find :

$$V = \frac{4}{3} = 1333 \text{ litres}$$

which is the quantity of air required for one person for one hour.

The German formula :

$$T = 0{\cdot}48\,\frac{V}{N}$$

gives a higher result, namely, 2084 litres, and it is safe to allow a circulation of 2000 litres of filtered air per hour per head on the open-cycle system for small shelters, and, say, 1500 litres per hour per head for large shelters.

As regards the floor area required, this is largely a question of comfort, but a minimum of 1 square metre per person should be observed.

In Fig. 5 is shown a typical shelter designed by Messrs. Sinrapt and Brice for a block of flats near the Bois de Boulogne, and placed under a little garden which completely covers the shelter and serves as a protection for it.

It will be observed that the shelter is circular, constructed of reinforced concrete with a domed roof and inverted floor. It has two separate means of access through airlocks from different parts of the main building, and is provided with an air filter and fan.

When the entrance to a shelter is in the basement or sub-basement of a building, it is necessary to provide some means of clearing the basement or sub-basement of gas when the alarm is over and before the inmates of the underground shelter are released.

This necessity arises from the fact that the gases used are heavier than air and, therefore, naturally collect at the lowest point. This is provided for by special fans, one of which, with a capacity of 30,000 cubic metres an hour, is shown in Fig. 7.

A more elaborate shelter designed for the accommodation of 400 people is illustrated in Figs. 6 and 9. This shelter is of two floors and has been constructed under one of the large administrative buildings in Paris, where 350 people are employed.

Fig. 6 shows the upper floor of the shelter, which can accommodate 200 people, and also contains two water closets, one lavatory, and fire services.

Fig. 9 shows the entrance to the lower floor, which will shelter 200 people, and also contains a machinery room.

From this shelter a staircase rises to the eighth floor of the building above, so that the entrance to the shelter is well above the level of any gas cloud. At the top of this staircase is the post of the signalman, who is provided with a telephone and with respiratory apparatus for his own use. This signalman has not only the duty of watching the sky for the arrival of bombarding aeroplanes, but he also has to supervise the functioning of the air locks and the ventilator, through which the air is drawn into the shelter at 1500 cubic metres per hour, and which supplies the filters for the open cycle. The signalman has to warn the machinery attendant, who is ten floors below him, of anything unusual, which might indicate that it would be prudent to close the shelter hermetically and to put the closed cycle into operation. This system of signalling is in addition to the use of gas "detectors" of the Gip-Malsalez type, which automatically put the closed cycle purifying apparatus into action.

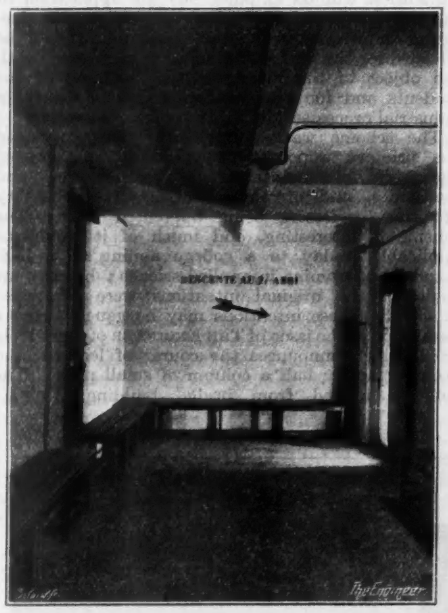


FIG. 9—ENTRANCE TO LOWER FLOOR OF UNDERGROUND SHELTER

Fig. 8 shows the closed cycle apparatus in this shelter, which is identical with that used in submarines. In addition to the oxylith apparatus, there is an auxiliary battery of ten cylinders of oxygen.

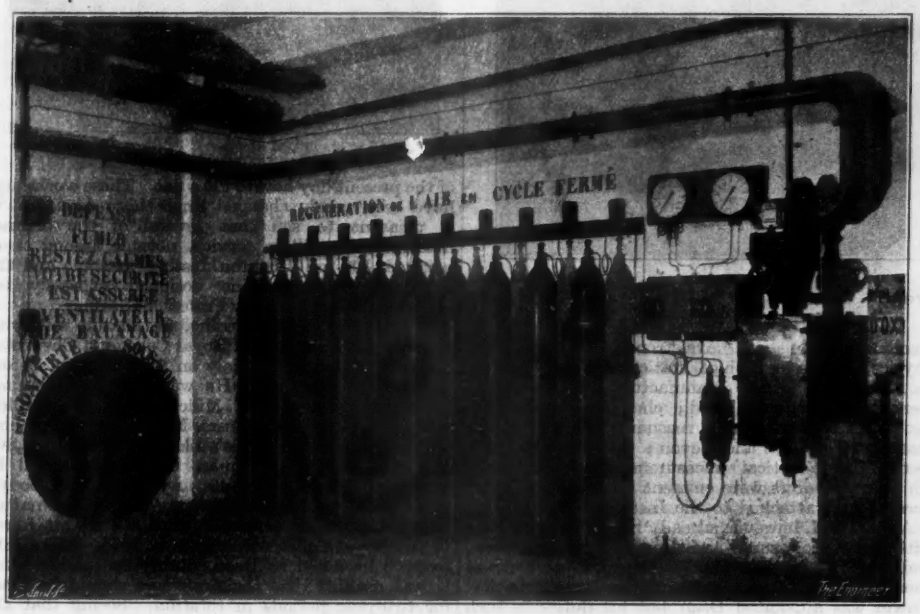


FIG. 8—CLOSED CYCLE AIR REGENERATOR

HERMETICALLY SEALED VEHICLES.

Gases, particularly chlorine, attack and destroy all foodstuffs other than those in sealed bottles, jars, or tins.

In all gas attacks standing crops and growing vegetables are completely destroyed in the back areas, even when the gas concentration is very slight.

It is therefore not only necessary to protect human life, but also the supply of food for the troops and civil population, whether in storage or in transit. Cold stores with the direct expansion system or brine circulation system in pipes are gastight, and means of storing other foodstuffs can be provided without much difficulty. For transport, hermetically sealed lorries are provided. These have an air lock door in the back, through which a person can enter the vehicle, and they are provided with oxygen cylinders for the driver, who is also in a hermetically sealed glass cabin.

These vehicles can be adapted for the conveyance of persons, and their doors are provided with the same form of pneumatic obturation as that used in the doors of the underground shelters.

Finally, a certain *personnel* is required to be on duty in air raids for the purpose of succouring the injured and gassed people in the streets. For this service these men are provided with a complete suit of air-tight rubber clothing and a respiratory apparatus, either consisting of a mere filter like an ordinary gas mask or with an oxygen-generating apparatus.

Though the danger of aerial gas bombardment is nothing like so serious in this country as it is in France, yet it is a matter which deserves, and no doubt is receiving, the most serious consideration.

The writer is indebted to the authors of the three papers mentioned and to the Council of the Société des Ingénieurs Civils de France for permission to make extracts from those papers and reproduce some of the illustrations, and to the Royal Artillery Institution for permission to reproduce Fig. 1.

Government Policy in Regard to Trade.

GOVERNMENT policy in regard to trade and commerce was the subject of an important speech by the President of the Board of Trade, Mr. Walter Runciman, at the annual dinner on Friday, January 25th, of the Penzance Chamber of Commerce. Mr. Runciman, referring first to the prosperity of horticulture in that part of Cornwall, said it had been accentuated by the action of the Government, which, up to the present time, had not even considered any intention of withdrawing the protection now given to horticulture. He was very doubtful about the wisdom of Governments interfering with trade at all. There were some of his colleagues in the House who were very fond of what they called "planning," which generally meant that those who had minds entirely unembarrassed by any of the sordid details of commercial life were able to plot out exactly what the future of trade should be. That kind of "planning" filled him with a certain amount of disquietude. He very much preferred to see the men actually engaged in commerce solving their own problems in their own way, and, on the whole, that had worked out best for them in the past. It might be that in many trades complete individualism and freedom had come to an end, but he doubted very much whether it had come to an end in commerce, for he drew a distinction between the two.

There were many trades which could be greatly helped by Government action, and many trades which could be seriously damaged by it, and they should be as careful to avoid doing damage by Government action as they hoped to do good by it. There were many indications in some quarters that the problems which confronted business men were to be thrown more and more upon the House of Commons and the Cabinet. He regretted that tendency. It might be necessary that they should take more action in these affairs, but he must say that he did it with great reluctance, for he believed it was only by individual effort that industry and commerce had been built up, and only by that means would it be maintained. The best way of holding the balance evenly between industries was to allow industries to find their own economic levels, and he had been reluctant to interfere except where interference had become an absolute necessity.

The actual production of goods was very largely a matter of scientific skill, of good organisation, and of the adaptability to new circumstances that had been very much a characteristic of British people for hundreds of years. But it was also essential that there should be skill in salesmanship. The world markets that had been won for Britain had been won on the whole by merchants. There was a constant tendency to exaggerate the evils brought to industry and commerce by the middlemen. The middleman was the man marked down for reprobation, and it was constantly said that his profits were excessive. Mr. Runciman pointed out that so far as Britain's foreign trade was concerned, the discovery of markets had been done almost entirely by pioneer merchants. It was they who had gone out to the uttermost corners of the world with suitable samples of British goods and had been able to capture markets which had ultimately grown to such volumes as to be the very backbone of many of the industrial districts of Great Britain. The middlemen of that foreign commerce were the men who had created business and who had found customers who never would have been obtained by Government action.

SOME of the difficulties of deducing the properties of a lubricating oil from tests on a bulk sample of the oil are discussed in a technical paper issued by the Department of Scientific and Industrial Research, entitled "A Study of the Boundary Lubricating Value of Mineral Oils of Different Origin," by Miss M. E. Nottage. The report deals with the conditions such as exist just before seizing between moving parts takes place, when the film of lubricating oil between two smooth bearing surfaces is so thin that the molecules on the outermost layer of one surface are within the range of the cohesive forces due to the outermost molecules on the other surface. In the experiments a number of commercial mineral oils obtained from as many sources as possible were examined.

The Central's Jubilee.

"FINSBURY," with its forty-six years of independence and practical policy, fostered at the beginning by those pioneers of technical education, Sylvanus Thomson, Armstrong, Perry, and Ayrton, has gone; but its younger brother, the "Central," continues to flourish and grow in importance. In fact, the Central, or, to give it its precise name, the City and Guilds College of the Imperial College of Science and Technology, celebrated its Jubilee on February 4th, and although a mere half-century is nothing in the ages of our classical Universities, it covers practically half the span of the industrial development of engineering in England.

The real beginning of the College dates back to 1851, when the great Exhibition attracted public attention to the importance of technical training in all branches of industry, and a Royal Commission urged the necessity for its provision. The Corporation of London and the Livery Companies were impressed with the pronouncement, but it was not until 1877 that a Provisional Committee was formed to consider the subject in a wide aspect covering the whole country. This Committee secured the assistance of a number of eminent men in science and industry, including Professor Huxley, President of the Royal Society.

The first result of the work of this Committee was the establishment in 1878 of the City and Guilds of London Institute for the Advancement of Technical Education. It will be noticed that the term was education, not knowledge—that is to say, the Institute was to organise schools, not provide the schooling directly, and it is plain that at that time it was hoped to cover all the industries of the country. From that idea, however, gradually crystallised out the present scheme of concentrating on engineering and physics. It must not be overlooked, however, that the Livery Companies do support a number of other specialised schools of handicraft and technique.

A start was made by appointing two comparatively young men—H. E. Armstrong and W. E. Ayrton—to organise classes in chemistry and physics in temporary premises in Cowper-street.

About the same time a site for the proposed College was obtained in Exhibition-road, South Kensington, from the Commissioners of the 1851 Exhibition, at a nominal rent—it will be remembered that that Exhibition was so successful that it resulted in a very considerable fund being available for public purposes. The handsome building of the College was designed by Mr. Alfred Waterhouse, and was completed in 1884 at a cost of about £100,000. Early in 1884 the Council of the City and Guilds Institute approved a "Scheme of Organisation," which was drawn up by Sir Philip Magnus in collaboration with Sir Frederick Bramwell, Professor Huxley, and others. This scheme stated that the objects aimed at were the practical, scientific, and artistic instruction of students to qualify them to become (1) technical teachers; (2) mechanical, civil, and electrical engineers, architects, builders and decorative artists; (3) principals, superintendents, and managers of chemical and other manufacturing works.

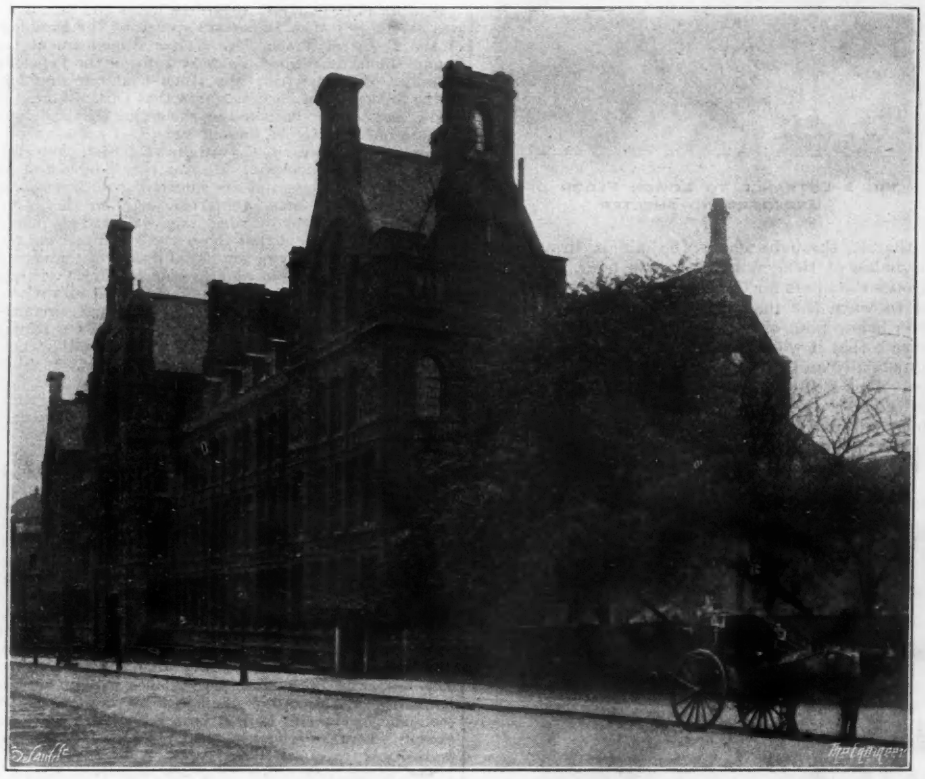
In this document it was emphasised that "The main purpose of the instruction to be given in this Institution will be to point out the application of the different branches of science to various manufacturing industries . . . and opportunities will be afforded for the prosecution of original research with the object of the more thorough training of the students and for the elucidation of the theory of industrial processes."

The scheme was comprehensive and envisaged the primary appointment of four professors—of chemistry, of engineering, of mathematics and mechanics, and of physics—with the probability of other professors being appointed later. The scheme is interesting, and much of it would be applicable to-day to a college aiming at a high standard of training in applied science; but as time went on the original intentions were somewhat modified. Those intentions may be gauged from a paragraph in the issue of THE ENGINEER of June 18th, 1886, which announces the course of lectures and occupies nearly half a column of small print. The subjects ranged from bridge building, Unwin; teaching chemistry, Armstrong; experimental physics, Ayrton; graphical statics, Henrici; plumbing, Maguire; candle manufacture and the treatment of by-products, Field; chemistry of tanning, Procter; brickwork and masonry, Slater; paper manufacture, Cross and Bevan; building materials, Dent; and optical measurements, Glazebrook. All these lecturers were eminent men, but were not permanently attached to the Institute.

A start had, however, already been made in 1884 with four professors—Armstrong, Unwin, Henrici, and Ayrton—for the four sections, respectively of chemistry, engineering, mathematics and electricity. Unwin was appointed Dean, but his duties as such were not very clearly defined.

These four men were all of strong character, and Armstrong and Ayrton had the advantage of having had five years' experience at the Finsbury Technical College in organising classes in chemistry and physics. Their influence in the life of the College is still felt, although the behaviour there is now very different from what it was in the early days. Old students will remember Professor Unwin lecturing with a cigar in his mouth; Professor Armstrong talking about coal "stuff"; Professor Ayrton repeating himself almost word for word after the first half of his lecture; and Professor Henrici mingling his explanation of vectors with the admonition "Well, gentlemen, please do be quiet" spoken in a rich gutteral voice. They were all admired by the students, and although the youthful spirit was sometimes more evident than the desire to acquire knowledge, the professors succeeded in giving the students a great fund of practically useful technical knowledge, and also in training them to think and act for themselves.

It is in this last-mentioned direction that the Institute has been most successful and valuable. Professor W. C. Unwin was pre-eminent in this direction. He had had a wide practical experience, largely under Sir William Fairbairn, in Manchester, and had been a professor at the Royal School of Naval Architecture and at Cooper's Hill for twelve years. He had a style of his own in lecturing, strolling back and forth on the platform and choosing his words with deliberation, while making many illustrative sketches on the blackboard. He held the office of Dean from 1885 to 1896, and seldom had occasion to exercise his authority. He was assisted in his teaching in the drawing office by Archibald Sharp, who devised a bicycle with an articulated frame that could only be ridden by a circus performer, and who put forward the theory that when a man resisted an outside force the work being done upon him should store energy in the muscles. Then there was "Pa" Ashcroft, who used to conduct surveying parties in Hyde Park to the annoyance of choleric colonels, who were led to believe that it was to be desecrated by a railway. There were other assistants, but we must not forget "Ergo," whose proper name was Mr. Gillet, who was in charge of the engineering workshops and taught many prominent engineers of the present day how to file a flat. These workshops have been vastly changed since those days, but it is pleasant to see that several of the original machines are still in service, notable among them being a 100-ton Buckton testing machine and the horizontal steam engine designed expressly for experimental purposes by Professor Unwin.



THE ORIGINAL "CENTRAL" BUILDING

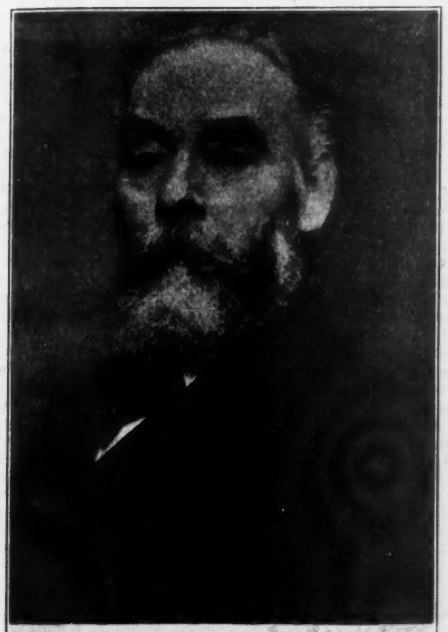
Professor H. E. Armstrong, fortunately still with us, was a student of the Royal College of Chemistry in 1865, and studied widely on the Continent before he went to Finsbury. He was, at the beginning, assisted by Messrs. A. K. Miller and N. H. J. Miller, and subsequently by Messrs. Moody and Pope (now Sir W. J. Pope)—Pope's skill in pouring H_2SO_4 out of a Winchester quart drop-by-drop will be remembered by old students, as will also Mr. Moody's private cake of soap. Professor Armstrong remained head of the chemical section until it was transferred to the Royal College of Science in 1913. From 1898 to 1900 he acted as Dean, during the period when it was decided that the professors should be Dean for two-year periods in rotation. Seeing that Dr. Armstrong is still very virile, in spite of his eighty-seven years, we will not attempt to describe his mode of lecturing.

Professor W. E. Ayrton was a student of University College, London, and a pupil of Kelvin at Glasgow. He had considerable experience abroad in telegraphy, and was appointed Professor of Natural Philosophy in the Imperial College of Engineering, Tokyo, Japan, whence he came to London in 1879. His first assistants were Mr. T. Mather—who later became Professor—who took charge of the laboratory, where light, heat and sound experiments were carried on, and T. R. Sowerbutts, whose duties in the workshop included the guarding against inquisitive students short circuiting the storage batteries through the mercury cups used in the place of switches. There were also Duddell, of oscillograph fame, and Mrs. Ayrton experimenting on arc lamps, but they were

not, of course, on the permanent staff. Professor Ayrton served two terms as Dean, from 1896–98 and from 1904–6.

Professor O. Henrici was educated in Germany, and was appointed assistant in the Mathematics Department of University College, London, in 1870. He became Professor and remained there until his election to the Central in 1884. He had as assistant Mr. (now Professor) H. Klugh, an ardent yachtsman, who flies the Blue Ensign, and did valuable work afloat during the war. Henrici had a remarkable aptitude in reaching from behind over the top of a blackboard and writing as fast as the students could take down their notes. He was the popular Dean from 1900 to 1902.

All four men selected for the new professorships were men in the prime of life, experienced, and possessed of both energy and originality. All four were, or shortly became, Fellows of the Royal Society, and all four attained to an international reputation. Though rumour has it that differences of opinion on occasions almost led to personal



quarrels (a situation inevitable with four strong personalities) they all did their best to support the prestige and usefulness of the College.

Two other personalities of the early days of the College must be mentioned. They were "J. J." and "Lines." Mr. John Jones was in charge of the library and generally supervised the clerical side of the business of the College. He was subsequently appointed Registrar, a post which he held until 1927, and probably has a better memory of the individual students than even had Unwin. Lines, the formidable head porter, had the difficult task of seeing that the students were on time in the morning and did not escape too early in the afternoon. The occasion of the ceremonial burning of the attendance book by the students was an indication of the independent attitude of both the students and the staff.

The first entrance examination to the College was held in February, 1885. The first students entered either by that examination or through transference from the Finsbury Technical College, and at the beginning there was a close collaboration between the two schools on account of the delay in equipping the laboratories at the Central. Students had sometimes to go to Finsbury to pursue their studies.

It was not until two years later that a full sequence of students, covering a three years' course, collected together, and within ten years the designed capacity of the Institution—200 students—was reached. At that time, the fees per session were fixed at from £25 to £30, but the expenses of running the College, which were borne by the Livery Companies and the Corporation, were more than double that amount.

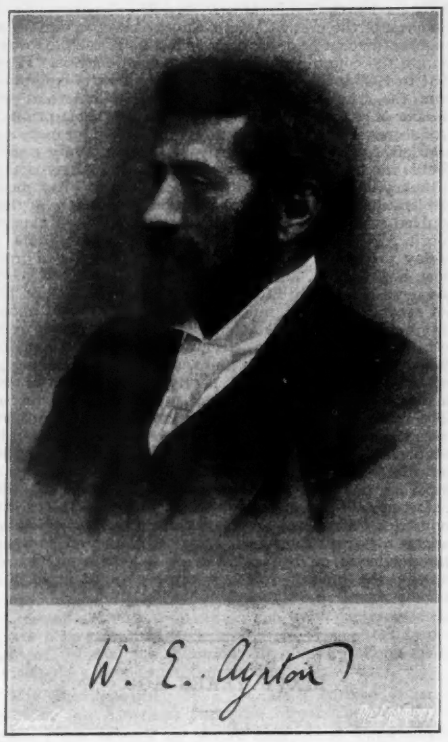
About that time—to be exact in 1893—the name of the College was changed to the Central Technical College, as it was thought that it would be more popular than the name of Institution; and almost simultaneously a violent attack was made anonymously on the conduct of the College. The assertions of that writer were completely refuted by a commission, which included, among others, Lord Kelvin, Sir (then Mr.) John Wolfe Barry, Professor Vernon Harcourt, and the then Director-General of Ordnance.

With this change in the name of the College came the system of appointing the Deans in succession, and the teaching staff was considerably increased, both by the appointment of new men and by the promotion of "demonstrators." The roll of students also increased to the number of 214.

The College was, at that time, free from all control by public examining bodies, and the College Board of Studies felt very strongly that the progress of the College and its quick adjustment to changing conditions would both be impaired if it became subject to a University Senate, such as the University of London, on which it would necessarily have only a small representation. But, on the other hand, the Board recognised that no College Diploma could have the same universal acceptance as a degree of a university, which would entail the College becoming a School of the University. The matter was considered over a long period, and finally, in 1900, a satisfactory compromise was reached and the College became a School of the University of London in the Faculty of Engineering. At the first internal final examination for the B.Sc. (Engineering) Degree, eleven degrees were conferred, and of these seven came from the Central Technical College.

As these long negotiations proceeded, the growth of the College continued and space became a pressing problem. In September, 1901, the number of candidates for the entrance examination was no less than 142 (of whom 101 passed), in spite of the fact that the fees had just previously been increased from £25 to £30 per session. The transfer of the School of Art Woodcarving to the Imperial Institute in 1897, and the discontinuance of the lectures on building materials, enabled Professor Henrici to use the rooms on the second floor on the south side as mechanics' laboratories, so giving more space for the Civil and Mechanical Department on the basement floor. The completion of the Royal School of Art Needlework in 1901 provided the Electrical Department with much-needed room for extension into the present machines laboratory and lecture theatre in the basement of that building.

Soon after this time one of the first radical changes

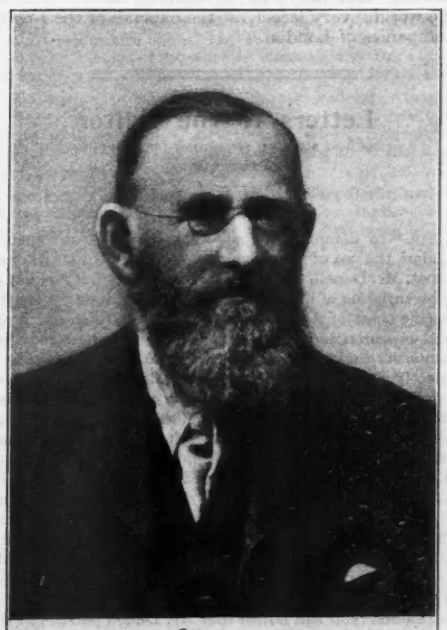


in the staff of the College took place, for Professor Unwin retired at the end of the 1903–4 session. He had then been at the College for twenty years and had been Dean for fourteen years. Although sixty-six years of age, he was still, however, actively engaged in engineering, as a consultant, and was elected President of the Institution of Civil Engineers and the Institution of Mechanical Engineers. He was also awarded the first Kelvin Medal. At that time he lived in a flat in South Kensington with his sister, and occasionally gave charming tea parties to the old students. At those parties one would approach him and say how do you do, when he would say, "Let me see, what is your name?" On being told he would say, "I remember, you were at the College in such and such a year," and his wonderful memory would be fully refreshed as to the personality of the student.

Another strong man, and one of a quite different personality, succeeded Unwin in Professor Dalby, who came to the College from Finsbury. He was a martinet, but nevertheless held the post of Dean from 1906 to his retirement in 1931. Under his *regimé* "rags" were suppressed, although it can never be said that Centralians ever brought their rags to public notice, except perhaps on Mafeking night; but about this time the College settled down to a far more serious attention to study than it had done in the past.

Of the four original departmental professors besides Unwin, Professor Ayrton died in harness in 1908, and Professor Armstrong retired in 1913, when the Chemical Department was transferred to the Royal College of Science. He is, however, still in intimate touch with his old students through the monthly luncheon party of the Old Centralians, a function which might well be more extensively attended. Professor Henrici retired in 1911, and left the reins to Klugh, until A. R. Forsyth took charge of the Mathematics Department in 1913. He was followed by A. N. White in 1923, and now there is Professor S. Chapman. It would seem, however, that the historical part of this account might well cease with the appointment of Dalby, about which time the name of the College was changed to the City and Guilds College, as subsequent events must be familiar to most English-speaking engineers.

The present appearance of the College, both inside and out, is very different to that of the days when the photograph we reproduce was taken. In fact, the whole air of Exhibition-road has changed. In 1909



the Goldsmiths' Company made a grant to the College, which enabled an extension that has approximately doubled the accommodation. This building was put up on the vacant land in the foreground of our illustration and was finished in 1914. It is of quite a different style of architecture from the old building, and is characterised by its airy rooms and halls. It is mostly occupied with laboratories, while the lecture theatres and rooms remain in the old building. The engineering workshops have also been greatly extended. In them there are now many more machines than there were forty or so years ago, and among them there are some of the original installation. The Pittler lathe, for instance, is still in service and in good order, as is also the 6in. lathe which the students built some thirty-five years ago. There are, of course, a number of really modern machine tools, but there is a notable absence of vices. It is obvious that the art of chipping and filing is not fostered as it used to be, and although it may be in consonance with modern methods of manufacture, some engineers deplore the policy. There was, within our memory, an engineer who, with no more original tools than a hammer and a chisel, built himself a complete steam launch; but it took a long time.

Although the tuition in the workshops does include quite a considerable amount of handicraftsmanship, its tendency is generally more towards the investigation of principles, and in this direction Professor Lander is most fortunate in the Goldsmiths' Extension. It is possible to carry out research work, which may require the undivided attention of several assistants, without the immediate prospect of educational value, although the subject may be of intense technical interest and promise to be of practical value.

Such investigations are, for instance, those on the dissipation of heat from hot surfaces, measured by the refraction of light passing through the layers of air or water adjacent to the hot surface, the light giving a continuous picture on a screen of the condition of heat transfer that can be scaled off in direct units. There is another experimental apparatus for showing the liability for turbulence to develop in converging hydraulic passages; and, in the electrical department under Professor Fortescue, who is, incidentally, the Dean, such investigations as those of Mr. Mordey on the classification of metallic ores by magnetic repulsion. Many more explorations are

being carried out besides the routine work of the sessional students, which is aided by a vastly increased equipment. For instance, testing machines—that is to say, machines for tension, compression, and bending tests—are spread among all the departments. The hydraulics "lab" has an experimental channel, 100ft. long, besides a number of turbines. Arches up to 20ft. in span can be tested to destruction, and model aeroplanes experimented with in a wind tunnel. There are a uniflow engine, a steam turbine, and sundry internal combustion engines to experiment with, and investigations are being carried out on heat transfer at high pressures.

The opportunities for study of the modern student at "The Central" are far in advance of those of fifty years ago, and it may be that it is that makes them appear so studious. Anyhow, they still have that buoyant happiness of contented students the world over.

There is one aspect of the College life that should be emphasised, and that is that a student having followed the course and secured his Diploma can feel assured that he has had a sound technical training, and has been brought up as a "man of the world," very largely at the expense of the Livery Companies of London.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STEAM OR OIL.

SIR,—In damning my advocacy of the steam engine, against the use of the oil engine, especially for small craft afloat, Mr. Dunell, of Vancouver, has merely put forward in substantiation of his contentions local conditions. On the Pacific coast of America oil is undoubtedly cheap, while coal is scarce and expensive. So that there, it may be, fuel costs rank very high in the total running costs of a boat if coal is adopted; but there is the alternative of firing a boiler with the locally cheap oil, and thus securing the advantages of lower repair bills, greater flexibility in manœuvring, and reduced lubrication costs at the expense of, say, a relative thermal efficiency of 12 and 33 per cent. As to his suggestion of lower wages, I am afraid that he is not familiar with conditions, as there are many steamboats on board which the engineer takes charge of both the engine and the boiler, while I can recall at least one instance where the total crew of a river steamer was only two hands—one at the wheel, to which the engine controls were extended, and a boy deck hand. The greater steaming radius (you will notice that Mr. Dunell persists in the term "steaming"), I will concede, but as to quicker starting, surely a boat which is earning its keep is always ready to go away, and if oil firing is used under a boiler is more trustworthy than the capricious oil engine.

CAPPADOCIA.

London, February 2nd.

ARTIFICIAL MANIPULATION OF TREND.

SIR,—A few years ago, having occasion to forecast the future sales of a public commodity, as water or electricity, I adapted the graphical analysis of previous year's output. Plotting the annual quantities as ordinates, time as abscissæ, the points showed a fluctuating curve moving upwards. The trend was drawn in by the method of Least Squares, and extrapolated to give a forecast. The estimate obtained is true within a range of probability. The probability of a true figure lying within any range is determined by the previously known fluctuation. The ranges used are a multiple of the "root mean squared deviation," and tables of Probability have been published in Metron.

Utilising this information a forecast for last year was previously made. Due, however, to exceptional circumstances, viz., an Act of God, the output was artificially restricted, so that, when plotted, the actual point was outside the expected range.

It has been suggested that this actual figure should be "corrected," *i.e.*, an allowance made for restrictions. If this is done, the weight of the low output figure, in the calculation of the trend, would be lessened. I am of opinion that the figure should stand, as if the figure be altered, it would upset the theory of probability; but I should be obliged to have another view on the point.

February 5th. D. LLOYD, M. Eng.

The Future of Industry.*

IN a period of rapid change and reorientation of economic activities, one of the main difficulties in estimating the state of trade is to find a suitable yard-stick for measurement.

We may perhaps avoid this difficulty by expressing the general opinion that present indications strongly suggest that we have either reached, or are close to the end of the first stage of the revival. In other words, we are back to a level which may be described as the normal under present world conditions. By this is meant that we can no longer rely for further expansion on the stimuli provided by such things as restocking, plant reorganisation, and the delayed demands of the slump period. Expansion beyond the present level depends on new business and new investment. It is when an attempt is made to visualise what is meant by new business and new investment that we come face to face with the main difficulty in forecasting the future.

As we have been at pains to explain in previous issues, the world is no longer advancing as a single unit. Trade between countries can no longer be described as in essence the interchange of food and raw materials for manufactured goods. Transactions similar to our own exchange of coal and cotton goods for food, raw materials and minerals are declining in importance. The present demand is for secondary goods. International trade is becoming less and less complementary and more and more competitive. We are one and all trying to solve our unemployment problems by making for ourselves the things we used to import. The tendency to expand outwards by emigration and overseas investment has been reversed. Immigration into this country now exceeds emigration overseas, and foreign funds are seeking safety in British domestic securities.

When we speak, therefore, of new business and new investment, we may not necessarily be referring to transactions which will foster the expansion of the spiral of international trade. We may be promoting a vicious circle of contraction.

While it may be early days to venture on a definite opinion, it cannot be denied that the past few years have witnessed a remarkable acceleration in the movement for setting up secondary industries in the overseas Dominions and other agricultural areas. Already it is an accepted principle in most of the arrangements for import control that the objective should be not merely to control the aggregate of imports, but to canalise them in the channels best suited to encourage the inflow, first, of food and necessary raw materials, and, secondly, of the equipment required for the formation of local industries. While the data available is insufficient to provide an actual measure of the rate at which these developments are proceeding, there are significant pointers.

It is daily becoming clearer that the economic impulse, which provided the mainspring to foreign trade in earlier days, has practically disappeared. It arose, initially, out of the existence of unexploited natural resources in newly opened territories overseas, and surplus populations and reserves of manufactured goods in the older countries. To-day the overseas countries are busily engaged in establishing secondary industries of their own, while the populations of the older countries are either declining or threatened with decline at a relatively early date. Since the onset of the present slump, the exploitation of natural resources (except gold) has entirely lost its attractive forces, despite the counter-pressure of industrial distress. From 1931 to 1933 inclusive, for example, the flow of emigrants from the United Kingdom was 119,000 less than the number of re-emigrants, many of the latter being primary producers. The number of primary producers, for instance, who left Australia permanently in 1931 was very nearly double the number of primary producers who arrived.

Meanwhile the pace of industrialisation has been accelerating. Industrial production in Australia has doubled within the last twenty years; in the Union of South Africa it has increased sixfold; while India is to-day producing the bulk of her requirements of iron, steel, and cement, and her output of cotton piece goods has increased nearly fifteen times since 1913. These are not exceptional cases, but symptoms of the general international trend. This is confirmed even in our own trade returns, which show iron, steel, and machinery as among the outstanding expanding items, both in our imports and exports. They constituted nearly 50 per cent. of the increase in our total exports of manufactured goods in 1934 and over 28 per cent. of our imports. Since in both cases the goods in question were employed in the main to establish in the areas to which they were consigned industries whose products were of a type previously imported, it is evident that we are entering a vicious circle. Unfortunately, unless the rate of expansion in the capital industries which have been benefiting from this re-equipment is to be maintained, either by still further encouraging this tendency or by taking steps to devise alternative outlets, the present recovery must exhaust itself and activity must lapse again.

* From the "F.B.I. Business Barometer," January, 1935.

SIXTY YEARS AGO.

THE name of the firm known as Yarrow and Hedley, of the Isle of Dogs, London, was becoming well known sixty years ago in connection with the building of light steam launches for river and similar work. In our issue of February 5th 1875 we recorded what was probably the first step taken in the series of developments which were to lead to the name of Yarrow becoming associated throughout the world with torpedo boats and torpedo-boat destroyers. In company with others we had been invited to inspect a "high speed torpedo launch" which the firm had just built for the Argentine Republic. The little vessel was 55ft. long and had a beam of 7ft. Her plating throughout was of Lowmoor iron and the framing of steel. She was driven by a pair of engines indicating 60 h.p. with which "a very high rate of speed" was stated to be obtained. The torpedo was in the form of an ordinary elongated projectile and held about 100 lb. of guncotton. It was carried at the end of a pole about 25ft. long projecting from the bow. Steel shields were provided to protect the crew from rifle shot. The method of igniting the torpedo was described as "most remarkable." Previously the usual practice was to fit the torpedo with a concussion fuze which when the torpedo was driven against the side of an enemy ship exploded the charge. Used in that way the torpedo was as likely to destroy the attackers as the attacked for the momentum of the boat would when she was driven against the enemy's side carry her forward and would almost certainly involve her in her enemy's ruin. The igniting system of the torpedo carried by the Yarrow and Hedley launch was the invention of Captain McEvoy, of the London Ordnance Works. A very simple detonating fuze was connected to three wires which passing down the pole were coupled to a battery in the launch. A brass cap was fitted to the torpedo and a very light blow on it was sufficient to establish contact and initiate the explosion of the charge. In addition the third wire was so arranged that the charge could be fired at any time without an actual blow being received by the brass cap. By these means the launch might steal alongside a ship and discharge her attack with a light touch of the torpedo against the enemy's side, her engines being simultaneously reversed full speed astern to back her off. If she did not deliver the attack head-on the torpedo could still be exploded by means of the circuit through the third wire. We added that Yarrow and Hedley proposed to build torpedo launches 100ft. long with a speed of 25 miles an hour. No ironclad afloat, we said, could run away from such craft, two or three of which would constitute a most dangerous foe.

THE INSTITUTE OF METALS.

THE twenty-seventh annual general meeting of the Institute of Metals will be held in the Hall of the Institution of Mechanical Engineers, Storey's-gate, S.W.1, on Wednesday and Thursday, March 6th and 7th, 1935. On Wednesday, at 10 a.m., the annual general meeting will take place, when the reports of the Council and the Honorary Treasurer will be presented. After the election of the Council and new members the following papers will be discussed:—"Corrosion Fatigue Properties of Duralumin with and without Protective Coatings," by Messrs. T. J. Gerard and H. Sutton; "Some Further Experiments on Atmospheric Action in Fatigue," by Dr. H. J. Gough and Mr. D. G. Sopwith; "The Effect of Five Years' Atmospheric Exposure on the Breaking Load and the Electrical Resistance of Non-ferrous Wires," by Dr. J. C. Hudson; and, should time permit, "The ε, γ, and β Phases of the System Cadmium-silver," by Dr. P. J. Durrant. At 2 p.m. the meeting will be resumed and the following papers will be presented for discussion:—"The Penetration of Steel by Soft Solder and other Molten Metals at Temperatures of Not Over 400 deg. Cent.," by Dr.-ir. L. J. G. Van Ewijk; "Type Metal Alloys," by Mr. F. D. Weaver; "The Constitution and Properties of Cadmium-tin Alloys," by Professor D. Hanson and Mr. W. T. Pell-Walpole; "Some Properties of Tin Containing Small Amounts of Aluminium, Manganese, or Bismuth," by Professor D. Hanson and Mr. E. J. Sandford. The annual dinner and dance will be held at the Trocadero Restaurant, Piccadilly Circus, W.1, at 7 p.m. for 7.15 p.m.

On Thursday, March 7th, at 10 a.m., the following papers will be discussed:—"The Reduction by Hydrogen of Stannic Oxide Contained in H.-C. Copper," by Dr. W. E. Alkins and Mr. A. P. C. Hallowes; "Unsoundness in Aluminium Sand Castings: Part III, Solidification in Sand Moulds under Pressure," by Professor D. Hanson and Dr. T. G. Slater; "Alloys of Magnesium: Part II. The Mechanical Properties of some Wrought Magnesium Alloys," by Mr. W. Prytherch; "The Spectroscopic Analysis of Aluminium," by Mr. D. M. Smith. The afternoon will be devoted to a visit to Battersea power station. The delegates will leave St. Ermin's Restaurant at 2.15 p.m.

THE ENGINEERS' GERMAN CIRCLE.

THE first meeting of the Engineers' German Circle this year, and the fifth lecture of the present session, took place on Monday evening, February 4th, at the Institution of Mechanical Engineers, when Dr. Ing. W. Zwanzig, of Siemens Schuckert (Great Britain), Ltd., gave a lecture on "Modern Electric Industrial Furnaces."

Over sixty members and guests were present, and the chairman, Dr. S. G. Davies, formally introduced Mr. E. L. Diamond, the new secretary. A warm vote of thanks was accorded to Mr. H. P. Spratt, who has performed the duties of honorary secretary for a period of over three years, ever since the Circle was formed. In his lecture Dr. Zwanzig traced the history of the electric furnace from its earliest beginnings up to the present large smelting, annealing, and industrial process furnaces. Various types and designs of arc, induction, and resistance furnaces were described and illustrated, and their load characteristics discussed. Along with lantern slides, Dr. Zwanzig showed two films of a modern electrical furnace equipped for heating aluminium ingots, and wire annealing, also typical installations of bright annealing furnaces for steel and brass strip and wire. The lecturer was heartily thanked by the chairman for an evening of widely varied interest. After the meeting members adjourned to the D'Abernon Club, 6, Carlton-gardens, where supper was served, and there was further opportunity for German conversation.

THE announcement of the London and North-Eastern Company that the freight train accommodation at Peterboro', East, Station—the terminus of the former Great Eastern Railway—is to be modernised, prompts us to remark that whilst the old Great Northern Railway, because of its main line to and from the North, has always been considered the predominant company at Peterboro', it was the last of four to reach that city. Actually, the London and North-Western arrived first—on June 2nd, 1846—with a west-east line from Blisworth. The Midland entered from the North on October 2nd, 1846, on a line of route which is now paralled by the East Coast main line. The Midland joined the L. and N.W., and made a joint end-on junction with the Great Eastern, which arrived from Ely on January 1st, 1847. The Great Northern entered Peterboro' on its own rails from Boston on October 17th, 1848, and it was by a connection laid in by the Midland Railway that the Great Northern reached the Great Eastern station. It is for the coal trains from the former L. and N.W. to the old Great Eastern that additional accommodation is required, and it is claimed that when the marshalling yard at Peterboro, East, is completed it will be one of the most up to date in the country.

Rail and Road.

THE driver concerned in the Lagny railway disaster of December 23rd, 1933, was acquitted on January 24th of the charge of culpable homicide.

WHAT is claimed to be the most successful home air line in Great Britain is that of the Jersey Airways, Ltd., operating between Heston and Jersey and Southampton and Jersey. Part interest in the concern has now been acquired by the Great Western and the Southern Railway Companies, and a new company, Channel Islands Airways, with a capital of £150,000, has been formed.

A FURTHER fourteen L.M.S. railway locomotive depôts in various parts of England and Wales are to be modernised during the year, and work is to be begun forthwith. The depôts concerned are Accrington, Agecroft, Bank Hall (Liverpool), Bedford, Bolton, Hasland (near Chesterfield), Holyhead, Lostock Hall (Lancashire), Low Moor (Bradford), Lower Darwen, Mold Junction, Preston, Rose Grove (Lancashire), and Tilbury (Essex). Included in these schemes is the provision of a mechanical coaling plant for the coaling of engines. With the exception of Holyhead, Tilbury, and Hasland, mechanical ash-lifting plants will also be installed.

THE London, Midland and Scottish Company has four divisional engineers, stationed respectively at Crewe (Mr. W. E. Thornhill), Manchester (Mr. S. D. Cotton), Derby (Mr. E. H. d'E. Darby), and Glasgow (Mr. A. H. McMurdo). We some time ago heard a rumour that the staff at Crewe was to be transferred to London, with offices in the Midland Grand Hotel. Later, we further heard that the Manchester and Derby people were to be similarly removed. We now learn that Mr. Thornhill's staff were removed on Monday last, February 4th. We believe that the other changes are to be made on June 1st. There will be no change at Glasgow as the policy of the company is to leave all Scottish administration in Glasgow. The twenty-two district engineers remain unchanged.

NEARLY 3,000,000 bricks have been transported by the L.M.S. from a Lancashire brickworks to the bottom of a tunnel under Mumbles Head, near Swansea, without a single brick being touched by hand intermediately. They form the lining of enormous subterranean tanks for the Swansea main drainage scheme. Every day five wagon loads leave the works at Accrington in containers, which, on arrival at Swansea, are unloaded by crane on to a motor lorry. At Mumbles Head, the containers are lifted off the lorry by another crane and lowered down the shaft on to trolleys in the tunnel beneath, whence they are conveyed to the working face many feet underground. By the time the contract is completed in the near future, 3,000,000 bricks will have been conveyed in this manner, in 6000 container loads, and the work will have taken a year to carry out.

SPEAKING on the Electricity Supply Bill in the House of Lords on January 31st, Lord Monkswell said that the whole gist of the Bill was in Clause 4, the heart of which was that it should be an encouragement to railways to go in for electrification. He believed that to be entirely wrong. He could not find the slightest justification for the statements about the magnificent results on the Southern Railway. Again and again the figures had been asked for at the annual meetings, but the administration did not give them. At the present moment the Southern Company was engaged in throwing good money after bad in electrifying greater and greater stretches of the line. It was a scandal. It was right to add that having frequently, at the L.N.E.R. meetings, said many hard things about Mr. Whitelaw's administration, that gentleman was, he thought, perfectly right in his policy therein.

THE trial of driver David Kerr on a charge of culpable homicide, arising out of the Port Eglinton, Glasgow, collision of September 6th last, occupied the first three days of last week, and concluded with the jury returning a unanimous verdict of "Not guilty." The criminal proceedings being thus closed, it may be expected that Colonel Mount's report on the accident will soon now be published. We may, however, anticipate matters by saying that the driver claimed that he left Shields-road Station with "clear" signals, and that the home signal at Port Eglinton Junction was also in his favour. The latter indicated that he had a free run into Cumberland-street Station, so he "notched up" to take the train up the ascending gradient. As the engine was running tender first, Kerr had to turn round to do that, and he claimed that when he afterwards looked at the signal it had been put to "danger." The prosecution's case was that it was never at "clear."

THE Deptford Borough Council recently fixed some electrically lighted street lamps which were found to interfere with the lights of the semaphore signals between New Cross Gate and Brockley on the Southern Railway. The latter thereupon took up the matter with the Council, and pointed out that such interference was a violation of the Malicious Damages Act, 1861, and the Offences Against the Person Act of the same year, that the company had been compelled to intensify the signal lights at a cost of £30, and that it looked to the Council to reimburse the expense. The General Purposes Committee admit the liability, and recommend that the sum be paid. We would add that these two Acts—24 and 25 Vic. c 97, and 24 and 25 Vic. c 100 respectively—received the Royal Assent on the same day, August 6th, 1861; the former was against the intention "to obstruct, upset, overthrow, injure or destroy any engine, tender, carriage or truck using such railway," and the latter dealt with the intention to "endanger the safety of any person travelling or being upon such railway." In both Acts this particular matter is referred to in identical words: "Unlawfully and maliciously make or show, hide or remove any signal or light upon or near to any railway." That this and other similar offences should have been dealt with in separate Acts was probably because both are consolidation Acts. We are informed by the Southern Railway Company that the intensified light is being given by a long-burning oil lamp of a special pattern, made by the Lamp Manufacturing and Railway Supplies, Ltd. The principal features of the lamp are an enlarged oil burner, giving an intense white light, used in conjunction with a highly polished optical lens.

Miscellanea.

IT has been decided to widen Richmond Bridge, from 25ft. to 36ft., at a cost of £73,000.

THE gold output of Canada during 1934 is estimated at 2,964,395 fine ounces, valued at over 61 million dollars.

IT has been decided by the Warwick Town Council to construct a new reservoir at Hatton, at a cost of £6000.

THE South Shields Town Council has decided to defer the whole question of a tunnel under the Tyne for a year.

THE Council of the Institution of Electrical Engineers has made the thirteenth award of the Faraday Medal to Dr. F. B. Jewett (New York).

FARADAY HOUSE, the department for Empire and foreign telephony, is to be extended by acquiring the building in Queen Victoria-street of the Civil Service Stores.

THE total quantity of coal shipped overseas from this country during 1934 was 39,659,986 tons, as compared with 39,069,926 tons in 1933 and with 38,989,801 tons in 1932.

A WATER supply scheme costing £87,000 has been approved by the Driffield (Yorks.) Rural District Council. The scheme covers the whole of the forty-one parishes in the district.

IT is announced that, owing to ill-health, Mr. G. Topham Forrest, architect to the London County Council and superintendent architect of metropolitan buildings since 1919, is to retire at the end of March.

DURING the quarter ended September 30th, 1934, there were 2,415,946 licences current for mechanically propelled road vehicles, as compared with 2,297,326 in the corresponding period of 1933, an increase of 118,620.

A DONATION of £20,000 has been made by Sir John Priestman towards a new library at the Sunderland Technical College, while the Miners' Welfare Central Committee has promised £7500 for a new mining department.

AN article in the *Electrical Times* describes a 100-kW windmill power station which has been running successfully at Balaclava, in the Crimea, for two years. It is stated that steps are being taken to multiply this unit by thirty or fifty, producing 3000 kW or 5000 kW groups.

NO new large water power developments were initiated in Canada during 1934, although work continued on undertakings already under construction at the beginning of the year brought into operation installations to the extent of 214,965 h.p. The total installed water power of the Dominion is now 7,574,035 h.p.

DURING 1934 the copper output of Canada amounted to over 367,054,470 lb. For the same period nickel output, consisting of refined nickel, nickel in nickel oxides sold and in matte exported, totalled 130,346,400 lb. Lead production is estimated at 342,811,000 lb., zinc at 300,747,113 lb., and silver at 16,350,029 fine ounces.

REMARKABLE results have been achieved with a magnetic truck for removing puncture-producing material from roads in New Zealand. During recent months in the South Island of the Dominion the truck, which is owned by the Main Highways Board, removed an average of 3·2 lb. of puncture-producing material from a mile of road. In a stretch of 918 miles of road, 2927 lb. of iron was lifted.

A NEW works for making concrete bricks has been established at Colnbrook, where a machine has been installed capable of turning out 5000 bricks an hour. The bricks are the same size as, but heavier than, the ordinary clay brick, 1000 weighing approximately 3 tons. In addition to the plain concrete brick, it is proposed to make facings, using a finer aggregate and coloured cements. The plant is expected to be in full operation shortly.

AN extract in the *Iron and Coal Trades Review*, dealing with recorders for registering roll pressures, states that the new elastic pressure gauges for measuring roll pressures are located between the top roll and a counter-bearing. These gauges consist essentially of an enclosed chamber containing only mercury, with the top pressure plate made of special steel. A pressure on the plate compresses the space above the mercury and forces the latter into a contact column, the different roll pressure stages being indicated by lamps on a connected indicator board.

FOR the depositing of a jet black surface on steel products, an American firm, the Alrose Chemical Company, has placed on the market Jetal salts, the aqueous solution of which will produce a deep black, scratch-proof surface in about five minutes. No baking, spraying, plating, or other complicated procedure is required. The bath is prepared by dissolving the salts in water at room temperature. A welded steel container is used for the liquid, which is heated to a temperature of 130 deg. Cent.; the parts to be blackened can be handled on racks, in bulk, in baskets or barrels, depending on their nature. A cleansing prior to immersion is necessary, and all oil or rust spots must be removed and pickling solutions must be completely washed away. The manufacturers state that the finish will not chip, scale, peel, or discolour. Blackened strips can be worked without impairing the black surface. Samples of polished steel can be blackened to produce black mirrors of high lustre.

A NEW method of hot galvanising is being introduced in this country by Messrs. J. M. J. Maus and Winn. The process is known as the "Aplataer," and the principal feature of it is that the greater part of the bath is filled with molten lead, on which a patented dividing liquid floats, and in turn supports a layer of pure spelter a few inches deep. It is claimed that no matter how violent a disturbance be set up when an article to be galvanised enters, the three materials do not mix, and always settle down afterwards into their former positions. The advantages claimed for the new process are the complete absence of waste spelter; the formation of hard spelter is negligible, and what does form adheres completely to the article being dipped, leaving none in the bath; increased flexibility of the coating, making possible deep stamping, bending, or twisting of the galvanised article. Economy of spelter is effected, as a thinner coating can be applied without impairing the resistance to corrosion, whilst flaking and cracking are said to be eliminated.

Air and Water.

THE new French 1500-ton submarine "Casabianca" has been launched. She is 303ft. long, 30ft. beam, and has an action range of 9000 miles.

THE National Maritime Board has decided to restore a quarter of the wages cuts imposed on the men and officers of the mercantile marine in 1932.

THE Segrave Trophy for 1934 has been awarded to Mr. Kenneth Waller, the British airman, for his flights to and from Australia and the Belgian Congo.

THE new French destroyer, "Le Terrible," on her trials at Loriente, is reported to have reached the speed of 45·05 knots, thus becoming the fastest vessel of her type in the world.

OUT of a total of 432 vessels chartered on the London freight market by the Russian Government in 1934, 314 vessels were British. In 1933, of a total of 485 vessels chartered, only 201 were British.

THE British Gliding Association has been reconstituted, and the London Gliding Club has re-entered the Association, which has now become qualified to receive the subsidy of £5000 a year for five years from the Government.

FOR his attempt on the American non-stop Trans-continental record flight, Mr. Wiley Post plans to drop the undercarriage of his machine immediately after taking off and to use a skid fixed beneath the fuselage for landing.

A REPORT of the United States Federal Aviation Commission advocates the increase of military aircraft by 80 per cent. and the construction of two rigid dirigibles, similar to the "Graf Zeppelin," one being for trans-ocean commercial flying.

A GERMAN aeroplane on the Königsberg-Berlin section of the Moscow-Berlin air route crashed on January 31st last, eight passengers and the crew of three being killed. The machine ran into very bad weather and was trying to make an emergency landing at Stettin when it crashed into a hill.

AT the end of 1934, Germany owned ocean-going vessels—that is, ships of 3000 tons and over—totalling 2,576,242 tons gross; liner tonnage accounted for 1,680,638 tons, or 65·2 per cent.; cargo vessel tonnage for 764,546 tons, or 29·7 per cent.; and tanker tonnage for 131,058 tons, or 5·1 per cent.

THE Air Ministry announces that the expansion of the Royal Air Force by forty-one squadrons, mainly for home defence purposes, necessitates a greatly increased intake of *personnel* during the next four years. A large proportion of this increase will consist of boys, 1500 of whom will be required during the next twelve months.

IT is announced in the *Journal of Commerce* that underwriters of the liner "L'Atlantique" have notified the owners, Cie de Navigation Sud Atlantique, that they do not intend to exercise their right to possession of the ship, which otherwise would become their property in view of the fact that they have paid a total loss under their policies.

THE annual summary of casualties to shipping during 1934, issued by the Liverpool Underwriters' Association, shows that there were 107 steamers and motor ships of 500 tons and upwards reported as totally lost, these comprising 9 motor ships of 31,538 tons, and 98 steamers of 276,524 tons, of which 2 motor ships of 6581 tons and 22 steamers of 69,255 tons were British. The number of partial losses was 5096.

THE first of twelve vessels of a new type for the French Navy has been launched at Nantes. They are called "escorteurs," and are, in effect, small torpedo boats, capable of a designed speed of 34·5 knots, and are intended for escorting convoys of merchant ships in war time. These "escorteurs" are some 264ft. long, 25ft. in breadth, and 14ft. in depth, and have a displacement of 609 tons. The armament will comprise two 100 mm. guns, five machine guns, and three 400 mm. torpedo tubes.

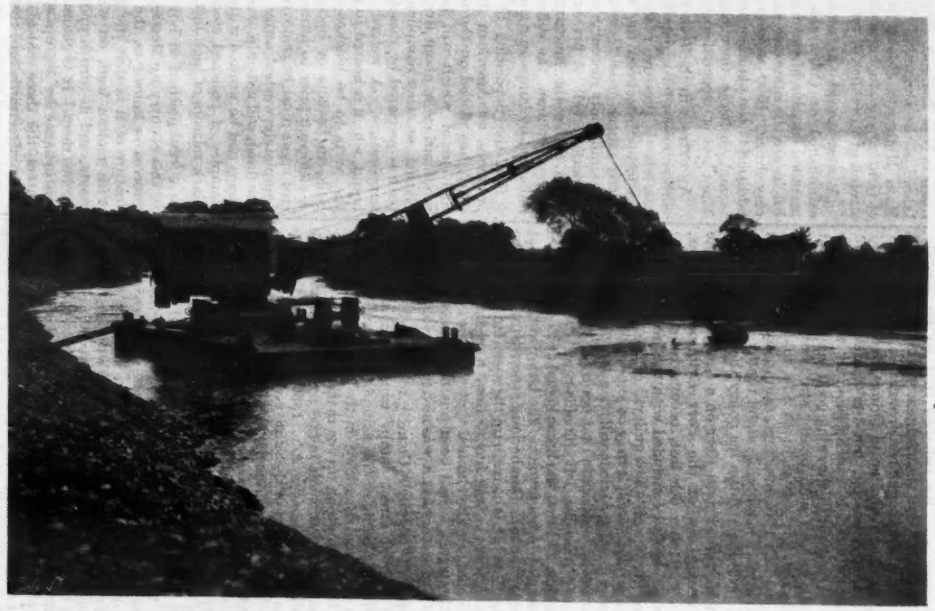
ACCORDING to reports from Washington, another international air race is under consideration, says *Flight*. If the necessary financial backing can be obtained, it is proposed to make the course from Washington to Buenos Aires and back, 18,000 miles. The route provisionally suggested is down the Atlantic Coast of North America and down the Pacific Coast of South America, crossing the Andes to Buenos Aires, and returning *viâ* Rio de Janeiro, Mexico, and Los Angeles to Washington. The proposed prize money is to be between £20,000 and £30,000, and the date is October or November of the present year.

DISCUSSING sprinklers in a paper on the prevention of fire in passenger ships before the Institution of Engineers and Shipbuilders in Scotland, Mr. G. E. Taylor said each sprinkler head receives most careful examination during every stage in its construction, and is finally tested hydraulically to a pressure of 300 lb. to 350 lb. per square inch. Sprinklers have been kept on a hydraulic accumulator working at a pressure of 1250 lb. per square inch for over a week, and the only sign of wear was a weakening of the elasticity of the flexible diaphragm. The cost of a sprinkler installation throughout a ship varied with the size of the vessel, but from a number of trial estimates the cost varied from 1 to 1·25 per cent. of the cost of the ship.

THE air port at Heston is to be extended and supplied with new buildings and equipment, which are to be ready for service during the present year. On the west side of the present air port buildings a large hangar with a 200ft. wide entrance is to be built. The total space available for aircraft in the new hangar will be 250ft. by 126ft., and on a second storey about one-tenth the area of the hangar will be utilised as offices for Airwork, Ltd., the controlling company. New accommodation has also been provided for the flying school and the two flying clubs which are attached to Heston. In order to facilitate night flying two 1,250,000 candle-power flood-lights are to be erected on the boundaries. A new type of boundary light is also to be installed which will consist of a lighted opal cylinder, 3ft. high, its purpose being to indicate the height of the amber boundary light above the ground.

THE WORK OF THE RIVER TRENT CATCHMENT BOARD

(For description see page 156.)



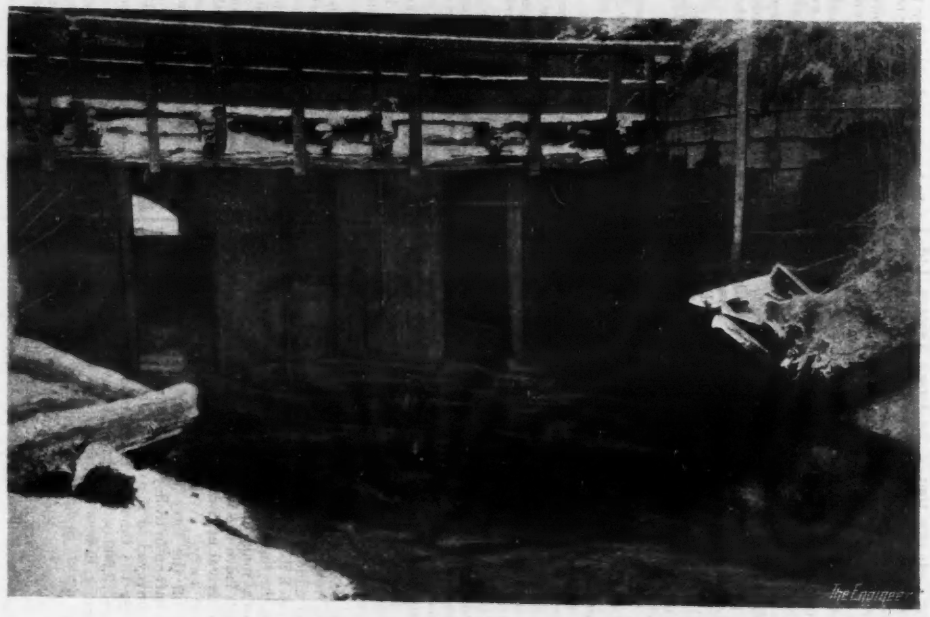


FIG. 1 (ABOVE):—BURST RIVER FLOODBANK AT COTTAM—MAY, 1932

FIG. 2 (BELOW):—AMPHIBIAN DRAGLINE EXCAVATOR ON RIVER TAME

FIG. 3 (ABOVE):—REINSTATED FLOODBANK AT COTTAM

FIG. 4 (BELOW):—HATFIELD WASTE DRAIN OUTFALL

The Engineer

FEBRUARY 8, 1935.

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NOTICES TO READERS.

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RAILWAY COACHES.

A CORRESPONDENT in our last issue made a dramatic attack on modern first-class railway coaches by writing his letter to us whilst he was suffering from the discomforts and defects which he detailed. We have no doubt that he will find many to support his views; for all of us are more ready to see faults than to acknowledge virtues. That is, perhaps, as it should be, and is, at any rate, a left-handed compliment to designers, for it indicates that the benefits which they provide have become so familiar that they may be contemned. Thus might a generation which has been brought up on white bread complain if it found in its breakfast roll one grain of bran. Our "Railway Traveller" almost implies that the railway passenger coach has made no progress since his father's day, and he seeks to parry an appropriate riposte by turning aside the familiar argument that weight counts. We may presume that he is a young man, for older men who can contrast the discomforts of railway travel fifty, forty, even thirty years ago are readier to recognise the merits of present stock. And being of the younger generation, or, shall we say, blessed with a young mind, he has we suspect an ideal of what a first-class coach would be. We hope he will send us particulars of it, but we anticipate from his observations that it would have practically unobstructed windows, that the seats would be independent and modern in design, that the air supply would be "conditioned" and draughtless, that the lighting would be individual rather than general—a strange requirement at this day—and that the coach would ride as smoothly as a Heavenly ice-yacht, and as silently as a questing owl. These are great ideals, but they are not all attainable at the present day. For the others the railway companies are moving towards them. There are trains in which the windows on the closed side cover the whole area of the compartment almost down to seat level, that have independent lighting for each passenger, and that run with little noticeable oscillation and are so silent that one may converse without strain. The ventilation and heating do, we agree, leave something to be desired even in the best stock of the day; but so they do in our dwellings and offices, which should present an easier problem.

However, we are not out to defend passenger stock and to claim that it is just as perfect as the circumstances will permit it to be. It has its defects, and fortunately railway men travel just as much as other people, and are just as keen in their criticisms—particularly of the other man's designs—as our "Railway Traveller" himself. Thus it is that we find each year bringing some new improvement, often of a kind which does not meet the eye, but adds to the subconscious comfort or convenience of the passenger. It is, we think, sometimes forgotten that it must take years before these improvements can be widely adopted, and by that time they will have themselves become antiquated. Railway passenger stock has almost as many "ages" as man. It begins in its prime on crack trains, and, descending through various degrees of dishonour, ends as a blot even on a bungalow town. Thus, on all railways will be found rolling stock of many ages. But the supply is always being replenished from the top, and we suggest that, out of fairness to the companies, only the latest designs should form the basis of criticism. No one would think of estimating the state of the motor car industry by an examination of last year's "models." If our Railway Traveller would try one of the latest trains—say, one of the "Scots" on the L.M.S., or the L.N.E.R.—we are confident that he would find many of his criticisms groundless. That is, unless he is opposed to the type as a whole and in general. The compartment type of carriage—derived from the old road coach—is peculiar to Europe and appeals particularly to Englishmen, whose love of privacy is proverbial; their ideal is one person per compartment. But there is a modern leaning towards the open, American, or "tramcar" design. Whether that leaning emanates from passengers themselves, or from designers who favour single-coach, high-speed trains, it is difficult to say. The railway companies obviously believe that for long journeys English people like the old-fashioned corridor coach, and presumably they are guided by experience. The open coach could almost certainly be made lighter and would be less costly. Hence, since it would suit the railways to build them if they really met the demand, we may conclude that unless the judgment of the companies is quite incredibly at fault, they must be supplying the kind of stock which their observations convince them satisfy the public taste.

Our correspondent's criticism was principally directed against what we might call the appointments of railway coaches. Our own would aim at a more serious and more difficult problem. We cannot think that the appointments on the best modern trains leave any grounds for serious complaint, and in many respects they are above those found in the homes of the travellers. Moreover, as each year goes by, some new amenity is added. No, the problem is not one of windows or ventilators, or arm rests, or door jambs. Great improvement has been made in the riding of coaches, but a great deal remains to be done. The test is to walk from one end to the other of a corridor and count the bruises on arrival. There is, we submit, far too much rolling and oscillation. How it is to be overcome we have no idea; no more have the railway people. They are continually struggling with the problem, but it still remains unsolved. This defect is veiled by the provision of more and more handsome, and more and more comfortable appointments; but it is there, nevertheless, a reproach to engineers—civil and mechanical. We would like to ask, also, whether it is a real fact or only a psychological impression that the cars which ride worst on any train are the dining cars? Possibly, reclining in a well-padded corner making no more effort than that required to support a novel, we do not notice the oscillations. When, however, we have to sit up at table and manipulate a spoonful of soup or a glass of wine, we become unpleasantly conscious of the difficulty of maintaining a balance, particularly if we happen to be seated over a bogie. The ideal coach should, of course, be like the ideal currant roll, all middle. Since that is impossible—or nearly impossible—the bogies of dining cars should be specially designed to give a period of oscillation that would not clash with the efforts of the diner to find his mouth at 60 miles an hour.

Electrical Research.

WHATEVER this country may at one time have lacked in the way of facilities for electrical research, it is now well abreast of others. Besides the ever-increasing activities of the E.R.A., N.P.L., and other organisations, such as the Post Office, research work undertaken by manufacturing firms is now of great importance. Nor are the many investigations carried out in technical schools and colleges to be ignored. The results that have emerged from past endeavours are reflected in the achievements of British electrical engineers who, since the advent of the grid, have demonstrated to the world that they are as capable as others of designing and constructing extensive electrical transmission systems. In practically all spheres of electrical engineering, research workers are constantly assisting those engaged on production. Research is at the root of much electrical progress. It has shown designers how to grapple with many troublesome problems, but let no one imagine that the industry can now afford to allow those who have rendered so much useful service to relax their efforts. The fourteenth annual report of the E.R.A. shows that the Association has a long list of researches requiring urgent investigation in the general interest, and the interest of particular sections of the electrical and allied industries.

Thanks to the support of the Central Electricity Board and to increased Government assistance, the Association's financial position has been considerably improved. At the close of 1934 it was in possession of a larger organisation, larger active programme, and larger income than ever before, but work calling for attention is still inadequately financed. Increased support from certain supply companies in the London area was particularly welcome. Nevertheless, there are, of course, many who benefit by the Association's work who either do not support it at all or who do so on too small a scale. The Association is spending more, for example, upon researches of special interest to the railway groups than it is receiving from them. Difficulty in gaining the full measure of recognition from all quarters is no doubt often to be found in the fact that it is not always easy for those deriving benefit to assess its full value. But, fortunately, this lack of full appreciation is not universal. The direct value to the Central Electricity Board of much of the work done and the prospective value of important tasks in hand have, for example, been fully recognised, and an appeal to the Board for financial assistance was sympathetically received. Although it was felt that the time had not arrived to make a general subscription, the Board agreed to contribute to the total cost of certain important researches on surge phenomenon concerning the design and protection of plant. The contribution averages about £7000 per annum over a period of three years, of which 1934 was the first, and it has enabled the Association to proceed with work of great interest to the industry in general and to the Board in particular. The Government's offer to increase its contribution pound for pound against new qualifying income furnished by the industry above that already in sight, is an indication that the Association's work is not being overlooked in official circles. On the manufacturing side appreciation is well exemplified by the increased support provided for investigations on the creep of steel. For several years the Association has been the principal contributory towards the cost of researches of this nature at high temperatures, work which, needless to say, is of the utmost importance to turbine manufacturers and users of steam at the higher temperatures and pressures. The researches have been under the control of a joint committee of the British Iron and Steel Federation and the E.R.A., but progress has been hampered by lack of funds. Owing largely, however, to the efforts of a conference called by the Association in the spring of 1934, under the chairmanship of the late Sir Alfred Ewing, many interested users have come forward with promises of support, whilst increased subscriptions have been obtained from manufacturers. Under the new conditions this work is being taken up during the present year, for the field is one in which international competition is keen, and more intensive research is highly desirable. Work on dielectrics has claimed the Association's attention for several years. Their behaviour under various conditions of electric stress with cyclic changes of all relevant variables, such as time, temperature, frequency, and humidity, has been studied. Side by side with the researches on the fundamental nature of dielectric loss phenomena, continuous attention has been given to the development of industrial test methods for the determination of dielectric losses under service conditions. The effects of corona on dielectrics, oscillograph studies of breakdown, and thermal resistivity are among other researches of special interest to producers and users of insulating materials. Of no small importance to communication engineers is the work on interference arising from power circuits which affect wired and wireless communication systems alike.

But any attempt to deal briefly with the more

important researches must fall a long way short of actualities. The important point to be stressed here is that despite the wide and varied nature of the Association's work, and the fact that subscriptions are coming in more readily than ever, electrical research can scarcely be over-subscribed. Great as the achievements of electrical engineers have been, no one believes that anything approaching the state of finality has been reached. To enable British engineers to hold their own with those in other countries, or, better still, to get ahead of them, research on an extensive scale is essential. The efforts of those engaged in the work may not always bear fruit as rapidly as some are perhaps apt to expect, for, as Mr. A. Berkeley says in a Foreward to the Association's report, no harvest arrives on the day seed is sown. Many lengthy, laborious, and costly investigations may be essential to grapple with some of the problems that demand attention, but just as in the long run research has proved profitable in the past, so will it bestow benefit on the industry in the future.

Scientific and Industrial Research.

THE report for the year 1933–34 of the Department of Scientific and Industrial Research was published on Monday of this week by H.M. Stationery Office, price 3s. net. Below we summarise certain portions of it of general engineering interest.

The Research Associations.—In its previous report the Advisory Council expressed the view that the majority of the research associations were operating on a scale totally inadequate to serve effectively the needs of the industries which they represent. Encouraging assurance was subsequently received from the Government that a movement to strengthen the associations would result in additional State aid being forthcoming provided the industries concerned showed their appreciation of the value of the work done by the associations in a practical manner. A conference with the leaders of twenty different industries, all possessing co-operative research associations, was held in March 1934 for the purpose of enlisting support for the movement to increase the associations' scale of operations. So far arrangements have been proposed and discussed with ten of the associations which will secure for them increased financial assistance from their industries and as a consequence also from the State. The aim of the Advisory Council is to increase the degree of permanence of the associations and to guarantee security to their scientific staffs. It is recognised that without these two factors there must be a drag on the activities of the associations and in particular upon the conduct by them of important investigations of a prolonged nature.

Road Testing Plant.—An opportunity for inventors would appear to be indicated in a statement made in the Report to the effect that very little progress in general research on roads will be possible until some means are available for judging durability other than by waiting for deterioration under normal usage. One method which has been followed is to lay down experimental stretches of roads; another and a speedier method which seems possible is to use road machines. A machine is required which will produce the same effect on model road sections in days as against years of normal wear. But it is important to realise that mere increase in rates of loading or artificial intensification of weathering agencies may be misleading. The time factor may profoundly affect such materials as bituminous compounds. Again, some estimate must be made of the effects of foundations and sub-foundations on the rates of wear when factors besides attrition are considered. The first step, once a reasonable type of machine has been designed, is to carry out some tests on samples of road sections whose durabilities are known, and so obtain a "scale." Having established the scale to which the machine is recording, it becomes a valuable instrument for estimating rapidly the probable performance of new forms of materials and construction. The basic considerations are that the road machine should be small enough to allow results to be obtained accurately, quickly, and at a low cost, while large enough to allow materials to be laid and tested in the closest possible accord with road practice.

Magnesium Alloys.—Considerable progress was made during the year in researches on magnesium alloys at the National Physical Laboratory. Specimens of rolled, pressed, extruded and spun magnesium alloy were produced and their mechanical properties were studied as rolled and after further heat treatment. One alloy containing 8 per cent. cadmium, 2 per cent. zinc, and 6 per cent. aluminium had an ultimate tensile strength of 26 tons per square inch and an elongation of 10·5 per cent. on the rolled rod. Magnesium nickel alloys containing up to 50 per cent. nickel were investigated by thermal and microscopic methods. The solid solubility of nickel and solid magnesium was found to be less than 0·1 per cent. Some exploratory work has shown that the alloys are unlikely to have useful mechanical properties. Some experiments were carried out to find whether an adherent coating of cadmium can be produced on a magnesium alloy by rolling together strips of cadmium and magnesium. The first experiments were successful and the coating appears to be a good basis for the electro-deposition of further coatings, but unless extremely thin coatings can be achieved the advantage gained may be outweighed by the disadvantage of an increase in specific gravity.

Water Softening with Zeolites.—Examples of three different types of commercial base-exchange materials were employed in experiments at the Department's Chemical Research Laboratory to soften waters containing calcium bicarbonate, calcium sulphate, and magnesium sulphate. Under the particular conditions of the experiments, representatives of the two main classes of treated minerals gave base-exchange values respectively equivalent to 0·4 lb. and 0·6 lb. CaO per cubic foot of material; these values were approximately the same for hard waters containing magnesium salts in solution as for waters containing calcium salts. The base-exchange value of a representative synthetic material was equivalent to about 1 lb. CaO per cubic foot with hard water containing calcium salts, but was equivalent to only about 0·7 lb. with solutions of magnesium sulphate. Many samples of British clays were treated by various methods with the object of preparing base-exchange materials suitable for water softening. In a few cases substances have been prepared with base-exchange values greater than those of some imported commercial materials.

Radio Direction Finding.—During the year the Radio Research Board examined in detail the present position of radio direction finding and, in particular, the state of the experimental investigations in progress on its behalf. The object of the review was to make recommendations for the future orientation and prosecution of the work. As a result the practical objective of this branch of the Board's work has been taken to be the seeking of an answer to the question: "Is an accuracy of plus or minus 1° in a single radio direction finding observation without exception attainable over either land or sea?" As far as this criterion is concerned no direction finder is at present entirely satisfactory, but short-wave direction finding is in an exceptionally unsatisfactory state having regard to its potential importance. The study of direction finding of short waves has accordingly been given a very high priority in the programme of work. At the same time there are many propagational phenomena on long and medium waves affecting the accuracy of direction finding whose importance cannot yet be quantitatively assessed. Moreover, the technique of investigation is much more complex in much of the short-wave work. For this reason it is necessary to approach many short wave problems by way of further investigation on the long and medium wave bands. The programme of work adopted by the Board accordingly includes a production of the most accurate Adcock spaced aerial direction finder it is possible to devise. Even assuming perfect apparatus, the objective aimed at calls for knowledge that the wave train under observation has not deviated by more than 1° from the vertical plane containing the sender and receiver or that the amount of greater deviations can be predetermined and allowance made for them. Whether such lateral deviations are absent is at present uncertain. The propagational problem involved is therefore also receiving attention.

The Welding of Steel Structures.—The investigations into the use of electric arc (metal arc) welding for structural steel work, which are being conducted on behalf of the Steel Structures Research Committee at the National Physical Laboratory with the collaboration of welding firms, have not proceeded as rapidly as might be desired though as rapidly as has been found possible. While the possibility of a non-destructive test of a welded joint has not been neglected, and certain investigations are in hand, attention has been concentrated on securing comparative data on the strength and reliability of welded joints made with different electrodes under existing welding technique. It is hoped to secure the co-operation of a large number of firms in the preparation of the samples required for this main series of tests. An examination is also being made at the National Physical Laboratory of the fatigue strength of certain typical joints.

Breaking Down Lump Coal.—Recent years have witnessed a change in the consumer's demand as regards the size of coal, and the demand for lump coal has fallen off as compared with the demand for smaller graded sizes. This change applies both to domestic and industrial requirements at home and to export coal and is partly, but not entirely, due to the lower price of small coal. Other factors which are influencing the demand are the greatly increased proportion of small coal that is mechanically cleaned, so that it is no longer necessary to buy large lump coal for the sake of its relative purity; the increased efficiency obtainable by a suitably graded coal, and the avoidance of the necessity of breaking before use; the diminished storage capacity in the modern house or flat; and the steady increase in the use of mechanically fired furnaces. This change in the demand is increasing the necessity for breaking down lump coal at the colliery, and raises the problem of how to break the coal to the sizes required with the minimum production of unwanted sizes and dust. Allied to this problem is that of preventing so far as possible further breakage during transit from the colliery to the consumer, and especially during the loading and unloading of ships and wagons. As a preliminary step in the examination of the technical problems involved, an officer of the Fuel Research Station is visiting the various coalfields, at the invitation of the colliery owners, to examine the conditions and determine what, if any, research can usefully be undertaken.

Friction of Stainless Steel Journals.—For the purposes of comparative tests with stainless steel and mild steel journals a sample of stainless steel which had proved to run unsatisfactorily in ring-oiled bearings was obtained by the Lubrication Research Committee. A series of observations showed that the friction losses were higher than with a mild steel journal under similar conditions. The journals were then repolished, using the same method for both journals and under these conditions the friction of both journals was similar. The effect observed previously appeared therefore to be due to a difference in surface condition. Since it appeared to be desirable to be able to measure the surface roughness, a special apparatus was designed which proves to be suitable for the purpose, and with small modifications is suitable for measuring the roughness of any form of surface. A description of this apparatus will shortly be published. Tests have been made to determine the speed at which fluid friction ceases, but these do not show any inferiority on the part of stainless steel. An investigation is now to be made with a ring-oiled bearing in order to ascertain that the stainless steel journal will take up the oil fed by the brass ring as readily as a mild steel journal.

Miscellaneous.—The propeller tunnel erected at the National Physical Laboratory through the generosity of Sir James Lithgow, Bart., is now undergoing calibration, and will shortly be employed in the investigation of propeller problems.

In the Metallurgy Department of the National Physical Laboratory the study of the physical structures of metals and alloys necessarily involves the use of pure constituents. In this connection the production of iron of high purity has received further attention. Analysis has shown that in the more recent samples of iron produced, the total impurities, excluding oxygen, amount to only 0·012 per cent., the nickel present having been reduced to 0·0006 per cent.

The air movements caused by wind in a timber yard have been investigated by the Forest Products Research Board. The tests indicate that a particular orientation of the alleys through a yard is not of prime importance, and that they will act as ventilation roads more or less irrespective of wind direction. It has been found that if the piles in a row are separated by about a foot, the space is ample to prevent any retardation of the drying process. The rate at which soft wood can be dried formed part of the test, and for 2in. material, a period of sixty days was required to attain a moisture content of 25 per cent., and ninety days for seasoning to 20 per cent. These times apply when the timber is stacked in early spring, and the seasoning process is assisted by the subsequent dry summer conditions.

Prolonged tests in air at 300 deg. Cent. on mild steel strips, subjected to stress locally concentrated at drilled holes and at machined notches, have now been in operation for five years on behalf of the Metallurgy Research Board. Although considerable local deformation has occurred, no cracking has developed. This result indicates that the presence of a chemical agent is essential for the development of cracking. Prolonged stress tests have been carried out in a specially designed steel cylinder, upon specimens of boiler plate immersed in a strong solution of caustic soda, under a steam pressure of 300 lb. per square inch, at stresses exceeding, and slightly below, the yield load. Further comparative tests are being made under both permanent and periodical stresses.

Obituary.

THOMAS SUGDEN.

By the death of Mr. Thomas Sugden, the managing director of T. Sugden, Ltd., of 180, Fleet-street, London, which took place on Friday, February 1st, at his home, Brooklyn, Underhill-road, Dulwich, steam engineers have lost a pioneer worker who did much to promote the introduction of new boiler and superheater designs, both for land and marine work. Although in his eighty-fifth year, Mr. Sugden took

an active part in his business, which he continued to direct personally until the end of last year.

He was born in Oldham and came of an engineering family. Quite early in life he entered his father's engineering works, and his practical training in the shops continued until he was twenty-one. His technical education was begun at Oldham Technical College, from which he obtained a Studentship at the Royal College of Science, London, and subsequently, at the age of twenty-three, a Whitworth Scholarship. After taking a full three years' course at Owens College, Manchester, now the Victoria University, Mr. Sugden was appointed an engineer with the Manchester Steam Users' Association, which experience gave him an opportunity of gaining knowledge that determined the course of his career in after years. Later he was appointed chief mechanical engineer to a firm of colliery owners, and subsequently he became manager of the Chadderton Ironworks Company, manufacturers of steam engines and boilers. When, over forty years ago, the Babcock and Wilcox water-tube boiler was first brought over to this country from America, Mr. Sugden became associated with the British Babcock and Wilcox Company, and he took a leading part in remodelling the boiler to meet British needs, and in incorporating in it the best principles of British boiler engineering practice. After leaving the firm of Babcock and Wilcox, he founded, in 1902, the engineering firm of T. Sugden, Ltd., for the design and manufacture of superheating equipment of all kinds. Perhaps the best service Mr. Sugden rendered to his profession was accomplished in the period during which he identified himself with his own firm. In the course of his business more than thirty patents were taken out by him for various types of superheaters.

During recent years Mr. Sugden devoted much of his attention to the Scotch marine boiler, and he evolved an improved form of uptake superheater for medium degrees of superheat. Apart from his business career he was a frequent contributor to technical discussions, and was a valued member of several technical institutions and scientific societies. Besides being a Whitworth scholar, he was a member of the Institution of Civil Engineers, a member of the Institution of Mechanical Engineers, an honoured Past-President of the Whitworth Society, and a Past Vice-President of the South Wales Institute of Engineers.

RT. HON. JOHN HENRY WHITLEY.

IT is with regret that we have to record the death, on Sunday, February 3rd, of the Rt. Hon. John Henry Whitley, the Speaker of the House of Commons from 1921 to 1928, and since 1930 the Chairman of the British Broadcasting Corporation. Mr. Whitley was born in Halifax in 1866, was educated at Clifton College and London University, and, before taking up his Parliamentary career, followed the business of a cotton spinner in his native town. Although he was not an engineer or scientist, we feel that his services to British post-war industry call for some mention. In 1916 the Government foresaw that the war would produce great changes in industry, and it set up a Reconstruction Committee on Relations between Employers and Employed. Both capital and labour were represented on this Committee, and Mr. J. H. Whitley, then Chairman of Committees in the House, was its Chairman. From the reports of that Committee, published in 1917 and 1918, came the remarkable movement for the establishment of Joint Industrial Councils, or Whitley Councils, as they came to be called; Works Committees, and an extension of the Trade Board system, which became an important factor in industry during the years immediately following the war. The machinery proposed by the Committee was never completely adopted, especially on the side of the establishment of Works Committees, and in many industries the Joint Industrial Councils and Interior Reconstruction Committees failed to stand the test of the slump. Over large tracts of industry, however, such as the printing trades, flour milling, pottery making, and on local government services, the Whitley system has taken firm root. With his retirement from the Speakership in 1928, Mr. Whitley by no means retired from public life. In 1929 he was appointed Chairman of the Royal Commission on Labour in India, while in 1930 he became the Chairman of the British Broadcasting Corporation, which he served with distinction.

JOSEPH HIGGINSON.

MR. JOSEPH HIGGINSON, whose death occurred suddenly at his home in Ashton-upon-Mersey, on the 30th ult., was in his seventy-second year. He was a man with a highly inventive brain and devised many appliances connected with textile machinery, with which branch of engineering he was chiefly connected as chairman of Arundel, Coulthard and Co., Stockport and Preston, and the Auto-vac Manufacturing Company, Stockport. His invention, which was perhaps the most remunerative was the auto-vac petrol feed for motor vehicles, which was almost universally fitted until it was superseded a few years ago by the pump. The auto-vac enabled the petrol tank to be placed at the rear of the car instead of under the dash, as was formerly the custom, the petrol being drawn by vacuum into a container under the bonnet from which it flowed to the carburetter by gravity. Mr. Higginson also invented another extremely ingenious device for the dashboard of cars, which enabled the driver to read at a glance the consumption of fuel in miles per gallon as the car was running, but this clever instrument did not meet with the same commercial success. In the earliest days of the self-propelled vehicle movement Mr. Higginson took a very active part in racing competitions in the North of England. Driving his own cars purely for the love of the sport, he won many events and still continued to occupy the driver's seat until the day before his sudden death. Mr. Higginson was a lover of the theatre, and his generosity was largely responsible for the maintenance of the Repertory Theatre in Manchester.

PROFESSOR HUGO JUNKERS.

THE death of Professor Hugo Junkers, which took place in Munich on Saturday, February 2nd, on the eve of his seventy-sixth birthday, removes an engineer and scientist of outstanding ability, whose work is recognised in many countries. Hugo Junkers was born at Rheydt, in Westphalia, in February, 1859, and he studied engineering at the technical colleges of Berlin, Karlsruhe, and Aachen. In 1890 he began his researches on the gas engine and about that time introduced the Junkers calorimeter for testing the heating values of gaseous and liquid fuels. In 1895 he started at Dessau the firm of Junkers and Co., which specialised in heating apparatus of all kinds. From 1897 to 1912 Hugo Junkers was professor at the Aachen Technical College. In 1907 he took out a patent for oil engines, and in 1910 he secured the patent rights for a glider. In 1913 he founded an engine works, and it is worthy of record that at this time he had on test a 4in. cylinder engine running at over 1000 r.p.m., which was the prototype of the modern high-speed oil engine for transport and aircraft use. When war broke out he devoted his attention to the construction of metal aircraft, his first all-metal aeroplane being finished in 1915. The Junkers Aircraft Company was founded in Dessau in 1919, the year in which Junkers completed the "F13," the first all-metal machine to be employed for civil aviation purposes. The Peace Treaty led to the closing of the Dessau works for a year, but, undaunted, Professor Junkers proceeded, with Government aid, to make his works one of the largest of its kind in the world. In 1920 he started works in Moscow, and in 1921 he inaugurated the first regular mail and passenger flights in Germany, his services being taken over by the Lufthansa Company in 1926. That year he again became the sole proprietor of the Dessau works, and he had also a large share in the Russian and South American Junkers undertakings, and he lived to see almost a third of the world's air services carried out with aeroplanes of his design. His scientific work was always based on sound first principles, which gave him a certainty in design, which led ultimately to great success. He financed his aircraft undertakings from the profits of his heating apparatus factory and was thus independent of outside financial help. His work will long remain, and his death will be regretted alike by internal combustion engineers and aircraft constructors in many lands.

Literature.

Time-keeping and Wages Office Work. By D. J. GARDEN, M.A., B.Com. London: Sir Isaac Pitman and Sons, Ltd. 1934. Pages 105. Price 5s. net.

EACH phase of office organisation deserves careful study, but while the duties of secretary, cost accountant, and labour manager have been considered exhaustively by a number of different authors, the important function of the wages office has never been honoured with independent investigation. Accordingly this little work is welcome.

The subject is dealt with in eight chapters, devoted respectively to a general examination of time-keeping problems; mechanical methods; the control of time-keeping; the pay roll; the payment of wages; punched card methods; internal checks; and finally an interesting chapter on the value of statistics. The author draws attention to the fact that one of the difficulties of organisation may be that often an office manager "exercises great ingenuity in complicating his own job"; certainly it is only when there is a full knowledge of all conditions that wise decisions can be made concerning the installation of expensive machinery and a number of other problems.

Many contentious issues are raised by the author, such as what classes of labour should use recording clocks, whether only the works operatives or the whole staff, even including the managing director. He suggests that the avoidance of all distinctions tends to promote a better team spirit, but we cannot help feeling that much might be said on the other side, and that when the upper staff enjoys certain privileges there is an added incentive for seeking to graduate for a place among the favoured few. Undue familiarity may breed contempt. In large works employees have frequently to walk a considerable distance after entering the gate, before reaching the actual scene of their labours. The question arises whether it is equitable to expect men to clock on in the immediate vicinity of their machine or bench. The more generous employer allows a definite "walking time," while others condemn the concession. The organiser must carefully weigh up the *pros* and *cons* and then justify his conclusion.

Many more problems could be cited from this interesting little work, but we cannot dwell on them, although it may be well to emphasise that the final solution of each will contribute either to the making or the marring of the whole organisation.

Mr. Garden gives a good description of the punched card method of analysing data, with special reference to the pay roll, but it is doubtful if a student who had not seen, say, a Hollerith machine could appreciate its possibilities without further elucidation. A time will probably arrive when a certain works can no longer be regarded as a small concern, when the manager ceases to know personally all the men employed, and we often wonder whether it is possible to state categorically when the full equipment of an office with calculating and other machinery is justified. The really small works obviously cannot afford such luxuries, the really large one cannot afford to do without them.

That definite savings will result from a carefully planned time and wages office is abundantly demonstrated by a perusal of the book before us, which usefully bridges a gap in existing literature on office organisation.

SHORT NOTICES.

Railways for All. Fourth edition, revised and enlarged by J. K. Taylor. London: Ward Lock and Co., Ltd. 1934. Price 6s. net.—This book was first produced several years ago by the late Mr. J. F. Gairns, and this—the fourth edition—will be found as interesting as the earlier issues. Opening with the history of railways and locomotives, the book deals in succession with locomotive working and types, famous express trains, railway workshops, carriages, royal trains, wagons, signals, time tables, electric traction, underground railways, railway building, bridges, tunnels, stations, goods traffic, &c. Intended primarily for boys, the lucid and interesting manner in which the book is written will retain the popularity gained by former editions with many who, not connected with railways or the engineering industry, follow closely this fascinating branch of engineering.

The Flow of Water. By G. Bransby Williams, M. Inst. C.E. London: Chapman and Hall, Ltd. Price 10s. 6d. net. 1934.—The object of this book is to give in a concise form as much as possible of the information regarding the flow of water that is usually required in an engineer's office. It is divided into four main sections—Velocity formulæ for sewers, pipes, and channels; velocity and discharges in sewers, pipes, and channels; discharge diagrams for weirs and notches; catchments—and is principally notable for the number of clear and useful diagrams which it contains. With the help of these diagrams rapid estimates of discharges under various conditions; loss of head; discharge through notches, and so on, may be made.

The Book of Speed. London: B. T. Batsford, Ltd. Price 5s. net. 1934.—This book contains a number of articles by the people actually concerned in racing and speed record attempts on land, sea, and in the air, and the fact that some of the records were broken even before the book was published makes their description none the less interesting. The graphic descriptions of the various authors are supplemented by a large number of illustrations, many of them unique, and all fine examples of photography. The book does not attempt to cover the technical side of the machines, but deals with their development and achievements. It will, we feel sure, be read with pleasure and interest by all.

BOOKS RECEIVED.

Lead Piping Tables. By P. Hunter, M.I. Mar. E. London: Crosby Lockwood and Son, Ltd., Stationers' Hall-court, E.C.4. Price 2s. 6d. net.

Engineering Applications of Electron Physics. By G. Windred. London: The Draughtsman Publishing Company, Ltd., 96, St. George's-square, S.W.1. Price 2s. net.

Riveting and Arc Welding in Ship Construction. By Commander H. E. Rossel, U.S.N. London: Crosby Lockwood and Son, Ltd., Stationers' Hall-court, E.C.4. Price 12s. 6d. net.

The Principle and Design of Precision Gauges for Interchangeability. By R. J. Foster. London: The Draughtsman Publishing Company, Ltd., 96, St. George's-square, S.W.1. Price 2s. net.

The League of Nations Organisation for Communications and Transit Enquiry on National Public Works. London: Geo. Allen and Unwin, Ltd., 40, Museum-street, W.C.1. Price 12s. net.

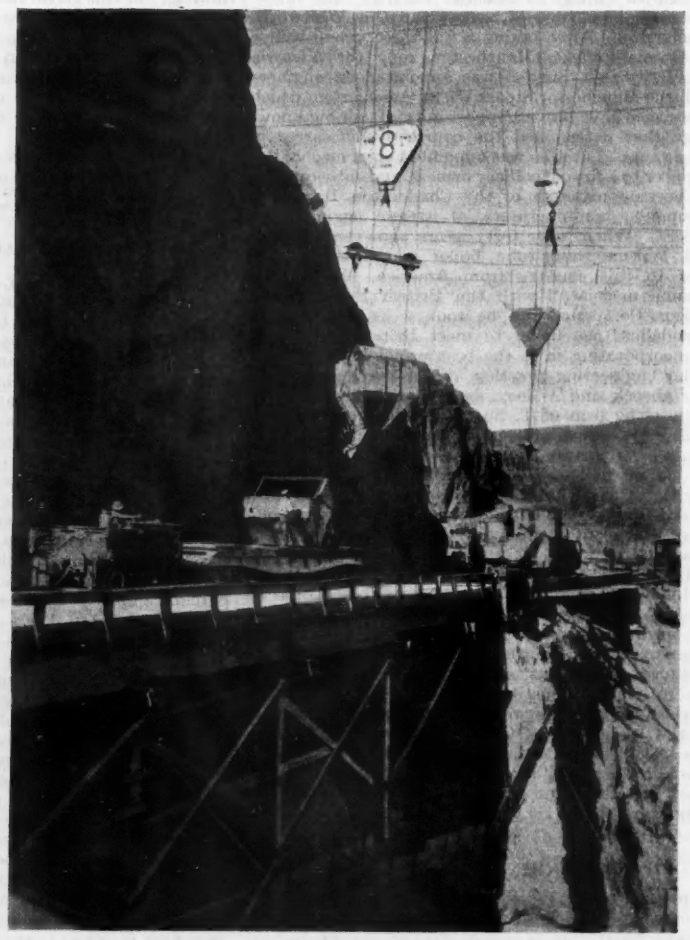
African Manual on Mining Industry and Agriculture, 1934–35. Edited by C. Carlyle-Gall. London: Mining and Industrial Publications of Africa, Ltd., Africa House, Kingsway, W.C.2. Price 21s. net.

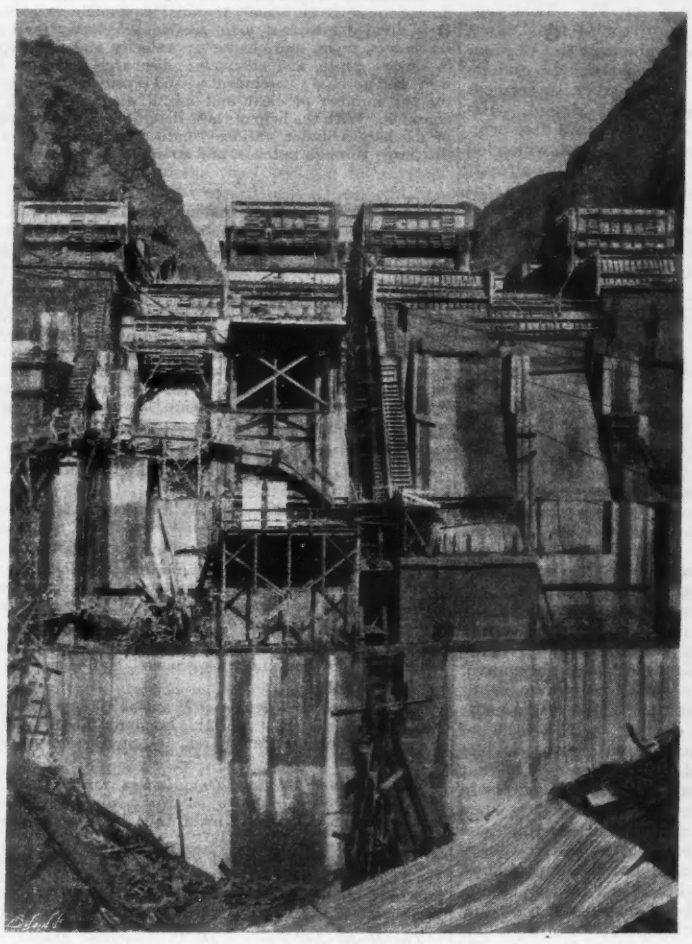
The Royal Air Force: Its Organisation, Duties, and Prospects as a Profession or as a Trade. By T. Stanhope Sprigg. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 5s. net.

The Colliery Managers' Pocket Book, Almanac, and Diary, 1935. Edited by H. Greenwell, F.S.S., and R. H. Walkerdine, B.Sc. London: The Colliery Guardian, Ltd., 30, Furnival-street, E.C.4. Price 3s. net.

THE BOULDER DAM ON THE COLORADO RIVER

(*For description see opposite page.*)





ABOVE:—FOUR CUBIC YARD TRANSIT MIXER
BELOW:—DOWNSTREAM FACE SHOWING CENTRAL COOLING SLOT

ABOVE:—RAILWAY AND CABLEWAY AT NEVADA RIM
BELOW:—UPSTREAM FACE BEFORE COOLING SLOT WAS SEALED—NOV., 1933

Progress on the Boulder Dam.

No. I.

IT is now a little more than a year since we described work on the Boulder Dam, then called the Hoover Dam, on the Colorado River. In the interval much has been accomplished. The first of the mass concrete for the dam, *per se*, was placed on June 6th, 1933. That concrete was poured at the bottom of the deep central cut, parallel with the thread of the stream, which had been excavated in the bedrock underlying the normal course of the river. Between that date and September 1st of the current year the general contractor, Six Companies Incorporated, had placed in the dam a total of 2,477,944 cubic yards of mass concrete—substantially 77 per cent. of all the concrete that will go into that structure to bring it up to the prescribed crest line 726ft. above the lowest point of the dam's foundation.

For the information of those of our readers who do not recall the general particulars of the Boulder Dam, let us repeat that it is of the arch-gravity type with an axial radius of 500ft., and will have, when finished, an approximate deadweight of 6,500,000 tons. In cross section, the base has a spread of 660ft., and the crest will have a width of 45ft. and a length of 1180ft. The height, as already mentioned, is 726ft. On September 1st, the dam had reached a height of 519ft. above its lowest point, and then there remained a rapidly diminishing mass to be poured to an added height of 207ft. to reach the designed elevation. The concrete has been placed at an average rate of 7000 cubic yards each twenty-four hours, although as much as 8000 cubic yards have been poured in that time. At the present rate of progress, the dam will be finished in the first half of this year, and by then sufficient water will have been impounded in the reservoir to start the generation of electric energy in the power plant in the canyon immediately downstream of the dam. In other words, the schedule agreed upon when the contract was awarded to Six Companies Incorporated in April of 1931 will be anticipated by fully two years.

Probably no other engineering task of a kindred nature has called for more intensive and diversified research. As a consequence, a special low-heat cement has been specified for the greater part of the dam; the method was adopted of rearing the dam as an aggregation of separate monumental, rectangular columns; the columns are being so arranged to provide both radial and circumferential contraction joints; all intercolumnar channels are being progressively grouted so that the dam when finished will be an immense monolith, and to facilitate the rapid construction of the dam and, at the same time, to prevent the development of cracks through volumetric changes in the mass concrete following its placing, a system of cooling the concrete has been employed for the dissipation of the heat of hydration in all but the lowest of the lifts of concrete. For the sake of clarity, let us deal separately with each of these divisions of the subject.

CEMENTS.

The low-heat cements are supplied by five mills situated in Southern California and Utah, some hundreds of miles away in each case. They are finely ground, and, compared with standard commercial products, are low in tricalcium silicate and tricalcium aluminate, and are high in dicalcium silicate. The low tricalcium aluminate content is counted upon to yield a more durable concrete than would otherwise be obtained. It is said that the low-heat cements develop during hydration only about two-thirds as much heat as would result from the use of the regular commercial cements. They permit also a marked reduction in the water-cement ratio and yet produce a concrete that is relatively easy to work. Although the development of strength in the low-heat concrete is slower than with concretes made with ordinary cements, still the final strength of the mass concrete will be greater than that commonly obtained. Uniformity in the mass concrete is realised by blending and controlling the composition of the low-heat cements originating in the different mills. Each cubic yard of concrete contains 1·01 barrels of cement, and a cubic foot of concrete weighs 156 lb.

Between June and August of 1933, the concrete poured in the bottom lifts of the dam was made with standard cements, but thereafter low-heat cements were available and have been since used continuously. Tests made during September of 1933 yielded data concerning the comparative values of concretes of the two kinds, and the following results obtained in the laboratory and in the field are informative :—

Test.

High-heat Cement Concrete.

	Field.	Denver Lab.
Net W/C by weight	0·56	0·53
Slump, inches	4½	3½
Actual 28-day strength	3760	4040
Adjusted 28-day strength	4250	4040

Low-heat Cement Concrete.

Net W/C by weight	0·53	0·55
Slump, inches	3½	3½
Actual 28-day strength	3210	3210
Adjusted 28-day strength	3310	3210

As a matter of fact, the field slump was ascertained at the mixers, and the low-heat concrete has given generally a slump of about 3in. at the forms. According to Byram W. Steele, designing engineer on dams for the Bureau of Reclamation, field strength is 8 per cent. higher than the strength determined at the Bureau's laboratories in Denver. This is the outcome of uniform loading conditions at the dam. Therefore, a field strength of 3210 lb. per square inch becomes 3467 lb. to the square inch in the structure. To obtain a high degree of uniformity in the placement of the concrete from batch to batch and to obviate segregation, holding the water content as nearly constant as practicable, the specifications required that as much of the mass concrete as possible should be placed with bottom-dump buckets. The buckets, especially designed by the contractor to meet this requirement, are of 8-cubic-yard capacity, and discharge when very close to the receiving surface. Near the abutting walls of the canyon, where restricted space and the shapes and sizes of the block forms have not permitted the use of the 8-cubic-yard buckets, concrete has been placed with the aid of 4-yard agitators transported on motor trucks to the edge of the canyon and moved thence by the cableways to the necessary points of deposition. An 8-cubic-yard side-dump bucket—see page 154—is also in use.

In THE ENGINEER for October 27th, 1933, was given a fairly comprehensive description of the principal features and equipment of the Lo-Mix plant that was situated far down in Black Canyon. For a considerable period that plant was the only source of concrete for the major appurtenant structures and for the dam itself. Towards the end of 1933 a second plant, known as the Hi-Mix plant, was built at a considerably higher elevation and also on the Nevada side of the gorge. Because the Hi-Mix plant is virtually a duplication in equipment of the Lo-Mix plant, we shall not enter into details about it. For a number of months, concrete for the dam was supplied from both mixing plants, but since July 1st of last year (1934) all concrete for the dam has been furnished by the Hi-Mix plant, the Lo-Mix plant having been dismantled soon after the dam had risen to El. 950 and the storage of water in the reservoir had begun. However, there was one convenience that served both mixing plants that should be described on account of its special interest; we refer to the facilities installed for the handling of bulk cement, the blending of cements received from the different mills, and the conveying of the blended cement to the two mixing plants.

Boulder Dam and its appurtenant works will require to complete them approximately 5,000,000 barrels of cement, which has to be transported from the mills by rail in box cars. Each car has connections in its roof so that the bulk cement can be loaded by gravity at the mills. A transverse bulkhead from door to door, on each side, divides the car so as to leave a free central passageway for an operator to unload the two bins thus formed successively. The bulkheads are made up of movable 3in. by 12in. planks. The practice has been to unload the cars and to transfer the cement into nearby silos by means of 40 h.p. Fuller-Kinyon cement pumps. The pumps are mounted on wheels to facilitate moving them and directing them into the carload, and each pump discharges into a flexible 5in. pipe that delivers the concrete into any of the storage silos. One pump can unload a car of 300-barrel capacity in about two hours, and an average of thirty carloads is thus disposed of in the course of three eight-hour shifts.

TRANSPORTATION OF CEMENT.

Early in 1932, when the placing of concrete started, cement was hauled by rail from Boulder City to the Lo-Mix plant, a distance of 18 miles, and there unloaded by Fuller-Kinyon portable pumps, which delivered the cement into storage bins set just above the concrete mixers. That procedure was followed for twelve months, during which substantially 600,000 barrels of cement were used in the making of concrete for tunnel linings and other diversion works. A change in the system became necessary when operations had reached the stage where concrete for the dam was to contain low-heat cement. That point was reached within two months after the lowest course of the dam had been placed. From that point onward, it became necessary to provide a cement blending plant that would serve both mixing plants, and that involved the transportation of the cement 14·5 miles *viâ* a circuitous rail haul on a route having a gradient in sections of 3·4 per cent. After studying the possibilities of railway, truck, tramway, and pump transportation, the engineers decided that pneumatic pumping would in the end be the most desirable method, provided equipment could be found that would meet the exceptionally exacting requirements. To be satisfactory, the pumping system would have to be able to transport cement at a rate of 450 barrels an hour.

The Fluxo pump was the only type suitable, but the longest distance a pump of the kind had previously moved cement was 1500ft., and while that was well within the potential capacity of the type, still the manufacturer, because of the importance of the installation, deemed it advisable to limit the pumping distance to not more than 3000ft., and proposed an installation of two pumps arranged to operate in relay. One pump was placed near the Hi-Mix plant and set between that plant and the blending plant. The second pump was placed 2600ft. away and about 550ft. lower down in the canyon. Fluxo pump No. 2 moved the cement a distance of 3000ft. to the Lo-Mix plant, where it raised the cement 100ft. so as to deliver it into the storage bins at that mixing plant. The pipe line throughout the 5600ft. section of the system was built of 9in. pipe, and most of the joints were welded. Between Fluxo pump No. 1 and the Hi-Mix plant the pipe line is of 6in. diameter, and the cement is transported a distance of 200ft. with a vertical rise of 130ft. This unit has handled as much as 1350 barrels of cement in the course of an hour. As dependability was an outstanding requirement, an auxiliary in the form of 2in. air inlets was provided at intervals of 200ft., and each inlet was fitted with a valve for manual control. Compressed air at a pressure of 150 lb. could thus be admitted progressively along the line to move the load of cement to the terminal points in case of pump failure. This auxiliary has not been called into service at any time. What is still more indicative of the efficiency of the Fluxo pumps is that the operation of the installation was so satisfactory that, after about six months of service, the line was arranged to by-pass pump No. 2, and pump No. 1 assumed the entire load of transmitting cement from the blending plant to the Lo-Mix plant more than a mile distant. That test indicated that the single unit could maintain the flow of cement without any appreciable reduction in capacity and, at the same time, bring about a saving of 10 per cent. in air consumption compared with the demand when both pumps were operating in relay. Thereafter, pump No. 2 was permanently removed from the line, and the single unit has since been doing the work without any occurrence of plugging.

During the period when the two pumps were in use, those units were so interlocked electrically that pump No. 1 would stop automatically when the cement had reached a prescribed high level in the surge bin placed above pump No. 2. At the Lo-Mix plant there was a control switch by which the operator there could stop pump No. 2 whenever it was desirable to do so, and that action automatically stopped pump No. 1 as soon as the line between pump No. 1 and pump No. 2 had been cleared of cement. The Fluxo pump does not call for any adjustment or attention on the part of the station operator whenever the rate of capacity varies. For example, should the feed to the pump fall below the rated capacity, or should the flow of cement to the pump be temporarily checked, then the pump is automatically stopped until the pump tank has again been filled to the required level, at which time it automatically resumes pumping.

The unit is provided with two tanks, which are mounted side by side on a structural support. Each has a capacity of fifty barrels of cement. As the cement passes by gravity through the inlet valve to one tank, the cement charge in the adjacent tank is expelled under air pressure into the transport pipe line. As soon as the discharging tank is emptied, then the operation is reversed and the tank that has been filled in the meanwhile is subjected to air pressure to bring about its discharge. Compressed air also agitates the cement before entering the pump, and by reason of the agitating action of the impulse air, while the cement is in transit in the pipe line, the blending done in the blending plant is supplemented.

Cement at the blending plant is stored in eight cylindrical steel silos, each of a capacity of 6000 barrels, and severally used for the storage of the different cements from the supplying mills. Vane feeders beneath the silos proportion the quantities of cement of the different kinds that are to be blended. The feeders, which are motor driven, can be controlled to discharge at a rate ranging from 50 barrels to 200 barrels per hour. From five of the silos the feeders discharge to an 18in. screw conveyor which mixes the cements and delivers the material to a second 18in. screw conveyor which carries the cement to a 500-barrel bin placed over the transport pump. Feeders beneath the other silos deliver to short 14in. screw conveyors which move the cement to the main 18in. conveyor. The controls for the motors of all the feeders and conveyors are interlocked and conveniently grouped, and none of the feeders can be operated unless the conveyors are working. This provision prevents the overflowing of the small bin directly above the Fluxo pump. By adjusting the reduction ratio of the variable-drive feeder motors, it is possible to control nicely the proportioning of the cements in a blend. Care is exercised to assure close uniformity in colour of the concrete in the dam, especially in the exposed surfaces. Because of the composition of the aggregates, the ultimate hue is a brownish shade which harmonises well with the rocky faces of the canyon. This will contribute to the scenic effect of the structure.

(To be continued.)

The Work of the River Trent Catchment Board.*

No. I.

The Catchment Area.

THE catchment area of the river Trent covers a large portion of the ancient kingdom of Mercia. It is 2,578,539 acres (4029 square miles) in extent and is the third largest in the country, those exceeding it being the Severn with 2,822,270 acres and the Yorkshire Ouse with 2,657,189 acres, whilst the average for all catchment areas is 541,160 acres.

The river Trent rises in the northern environments of Stoke-on-Trent and pursues a south-easterly course until it reaches its confluence with the river Tame near Alrewas, when it changes to a north-easterly direction and then from Newark to the outfall in the Humber it flows practically due north. All the main tributaries join the parent river above Nottingham, with the exception of the river Idle and its tributary, the river Ryton, which discharge at West Stockwith below Gainsborough. Generally speaking, with the exception of the river Derwent, which flows through a gorge of millstone grit in its length above Ambergate, all the main rivers flow through alluvial beds composed of gravel, until the river Trent reaches the vicinity of Torksey, where there is a fairly definite change to warp, which overlies clay in places. For the most part the geological formation of the lands contiguous to the valleys is the Keuper Marl, whilst the flat alluvial peat moors in the area of the Doncaster drainage district are notable. The total length of main river is 486·1 miles. This mileage represents 5304·5 acres per mile of main river, the largest acreage per mile in the country (except that of the Yorkshire Ouse, which is the same), whereas the average area per mile for all catchment areas is 3659 acres.

Preliminary Work of the Board.

Although the Board was constituted in May, 1931, it was not until October, 1931, that full-time officers were appointed, whose first duty was the setting up of an organisation capable of discharging the functions of the Board.

Commencement of Works, 1932.

The short period up to March 31st, 1932, having been devoted to matters of an administrative nature, the Board entered upon its first full year on April 1st, 1932, and sums of £26,320 for works of maintenance and £6480 for improvement of existing works were precepted from the constituent authorities. In May, 1932, a flood of great intensity visited the catchment area and demonstrated the weaknesses of the arterial drainage system. In this year an organisation was created for employing men by direct labour, and information is now set out indicating the policy adopted and the work accomplished. The first workman employed by the Board commenced work in May, 1932.

Works Policy of the Board.

Works fall under three main headings, namely :—(*a*) Maintenance, (*b*) improvement of existing works, and (*c*) new works.

Maintenance.—Apart from sundry works carried out and maintained by certain Internal Drainage Boards and County Borough Councils, there was no organisation of works for the Board to inherit, and a preliminary survey of the area indicated that, under the heading of maintenance, a considerable amount of pioneer work, such as tree clearing, removal of shoals and the reinstatement of flood banks, was necessary. It was also manifest that a complete hydraulic survey would have to be put in hand in order to prepare comprehensive schemes of flood alleviation. The general theoretical conception of river works is to commence at the outfall and proceed upwards, but in practice, and particularly in respect of large river systems such as the Trent, this principle cannot be applied because the requirements for land drainage in the different districts are so variable. For instance, obstructive trees and extensive shoal formations in the upper reaches cause persistent water-logging and minor flooding of the adjacent lands (both of which are avoidable) by enhancement of normal river level. The removal of such obstructions has a beneficial "local" effect, without adversely affecting conditions below. Derelict weirs, with neglected and unworkable sluices, merely cause the water to mount up and discharge in a series of steps. By improvements to the discharge capacities of such weirs the water is passed through at a lower level. Neglected flood banks are a continual source of danger when exposed to water pressure and the failure of one weak section, in an otherwise good bank, renders the service of the whole bank impotent against fluvial flood or tidal inundation.

The first work actually carried out by the Board was the reinstatement of the Cottam (Laneham District) flood bank following its failure during the May, 1932, flood; and photographs, reproduced in Figs. 1 and 3 on p. 150, respectively, show the conditions of affairs after the burst and the bank after its reinstatement. Whilst it cannot be said that this particular bank had been neglected, it was found that the material composing the bank was largely of a dry and sandy nature and unsuitable to withstand extreme water pressure. Flood bank maintenance is difficult in this respect, in that its weakness is not always apparent; moreover, it is frequently found difficult to obtain suitable material in localities where many lengths of flood banks require attention. Particularly dangerous are flood banks which have been constructed close to, or upon, the natural river bank, and there are many instances of such banks where erosion has all but eaten away the entire bank. In view of the urgent need for extensive flood bank repairs, the work of strengthening and reinstatement continued unbroken following the completion of the Cottam bank, whilst of the other forms of general maintenance, tree clearing commenced in the rivers Tame, Dove, Trent, and Sow in August, 1932, and dredging of shoals in the rivers Tame and Dove in November of the same year.

Improvement of Existing Works.—In certain respects it is difficult to place works under this particular heading, as, in practice, the line between improvement

FIG. 5—ON THE RIVER TRENT BELOW GREAT HAYWOOD

and maintenance is hard to define. Generally, it applies to the improvement of structures, such as weirs and outfalls, the re-alignments of flood banks, river diversions, and the like. Ancillary to the improvement of structures is the purchase of mills and weirs, either for removal or improvement.

New Works.—No new works have, as yet, been carried out, but they will apply to comprehensive schemes which will include new channels, flood bank systems, structures such as sluices, weirs, outfalls, bridges, and pumping machinery. The Keadby and Nottingham schemes, to which mention is made elsewhere, will be classed as new works.

Tree Clearing Operations.

The detrimental effects of the growth of trees on the banks of rivers are twofold, namely, obstruction to the flow of the river and erosion to banks by current deflection. Trees also constitute a harbourage for water rodents. On the other hand, there may be cases where trees have a definite value, as where they provide screens round a concave bend. The river Trent below Shardlow was found to be reasonably clear of obstructive trees, but in certain rivers, such as the Blythe, Dove, Ryton, and Soar, the actual watercourses were undiscernible in many places and the work of tree clearing from such reaches was of an extremely heavy nature. The photograph reproduced in Fig. 5 illustrates the nature of this work, and it may be mentioned that a considerable saving in time and manual labour was achieved by the use of monkey winches, a simple but powerful form of mobile machinery.

The greatest difficulty experienced has not been the actual removal of trees, but the disposal of the timber. It was essential that all fallen timber should be removed from the banks with as little delay as possible. Furthermore, all riparian owners and occupiers have been consulted—some 600 in all—both with regard to the actual clearing and subsequent disposal, and whilst many were very helpful and agreed to cart away the timber, others were not so inclined. In such cases steps had to be taken, either to find a willing recipient or to break up and burn the fallen wood.

To date the total miles of banks cleared is 417·6.

Removal of Shoals.

The removal of shoals is work of a maintenance character, which has been and will be continuous. The removal of obstructions created by shoals results in a lowering of the enhanced water level and the consequent free discharge of drains and watercourses flowing into the main river. The improved effect on lands, hitherto waterlogged, has been most marked, and in many cases drains have, after these operations, functioned which had been idle for many years past. In addition, the erosion of land caused by diverted currents has been averted. Whilst the loss of land due to erosion is not necessarily a liability of the Board, yet erosion usually signifies a river tending to set up a sinuous course, thereby encouraging an accumulation of shoals on the convex bends, and it is in the interests of land drainage that rivers should not get out of hand in this way. Until comparatively recent times a convenient dredging machine for working in rivers of shallow depths was non-existent, all machines, mostly of the grab or bucket varieties, operating from floating pontoons. The introduction of the drag line land excavator, however, has opened up possibilities of which full use is now being made. These machines are mounted on caterpillar tractors; they are mobile and can travel from place to place under their own power and, with the increased jib lengths that manufacturers are now able to supply by the development of welded steel, they can be considered the most efficient machines available for this type of work. Further, where rivers are too wide for the complete dredging from land and flotation for pontoons is possible the land excavators can travel on to the deck of a pontoon and operate from the water. In rivers interrupted by weirs over which a pontoon cannot pass the difficulty is overcome by means of a sectional pontoon. This consists of three or more water-tight steel boxes and the pontoon can be "broken" into its individual compartments which are then lifted separately over the weir by means of the excavator working as a crane, and re-assembled on the reach above. A machine alternatively operating on land or water in the manner described can be termed an amphibian, and a good feature of such a machine is that the operating machinery is never idle. In deciding on the most economic form of machine the three salient points to be considered are effective length of jib, capacity of bucket, and bearing load of the caterpillar treads. It is obvious that length of jib and capacity of bucket are interdependent considerations for the same machine, *i.e.*, the longer the jib, the smaller the bucket and *vice versâ*. At the same time, it may be pointed out that the length of a jib arm can be altered, in effect, by the angle of its set, and therefore the larger bucket can be used when the longer reach is not required. There are at present six excavators maintained by the Board.

A photograph reproduced in Fig. 2 shows work proceeding on the river Tame. The disposal of dredged soil has a similar relationship to dredging as that of the disposal of fallen timber to tree clearing. It is indeed useless to dredge shoals and merely dump the spoil on the bank, only to be washed back into the river again during the next wet period. Moreover, the dumped material would frequently be left on the land between the flood bank and the natural bank, which would merely mean a transfer of obstruction from the "summer bed" to the "winter bed." Consequently, before dredging operations have started a survey of adjacent lands has had to be made in order to find low or swampy places, which, with the owners' and occupiers' consents, have been used for disposal.

Weed Cutting.

This item of maintenance is highly essential because of the considerable enhancement of water level caused by weed growth and the obstruction to free flow. It is true that weeds only commence growing in the spring, and if unattended, die down in the late autumn, but the danger from flooding by heavy summer storms is always possible, when much damage can be avoided with a clean river. The cutting of weeds hitherto has been effected by means of special strung scythe knives, the work proceeding upstream so as to obtain the fullest advantage from the "bend" of the weeds and also, of course, to enable the cut weeds to flow down a clean course to selected places where they are pulled out. Floating weeds, if unextracted, would soon clog into large masses of serious obstruction, and although the expense of pulling out is greater than that of the actual cutting, it cannot be avoided. The growth of weeds is very variable in the different rivers, dependent upon the velocity of the current, the depth of water, the nature of the bed, river traffic, and the weather. Hot dry summers, such as have been experienced during the past two years, cause weeds to develop in certain rivers with astonishing rapidity, the combination of slack velocity and shallow water being ideal for their growth. The most difficult river in this respect has, perhaps, been the river Idle, the pulled-out weeds forming enormous stacks of vegetation, although, fortunately, these steadily reduce in

* Abstracts from the Triennial Report of the Board for the period ending October 31st, 1934.

volume as the weeds dry out and are subsequently burned. A total of 247 miles has been cleared.

REPAIRS TO BANKS.

There are two distinct kinds of banks, viz., the natural bank of a river and the artificial flood bank. The attitude to erosion of land has already been referred to, but if such erosion is affecting a flood bank, or tending so to do, it is necessary to arrest this destructive action in the interests of land drainage. All works, therefore, which have been carried out to the natural bank have had this regard primarily in view, although cases of concave development have also received attention, in order to conserve the line of the river. Generally speaking, and where a gentle sloping foreshore permits, lines of concrete bagging form the most economic type of defence of a permanent character, and the photograph reproduced in Fig. 6 illustrates types of this work.

Flood banks are barriers intended to confine the flood waters in the artificially produced enlarged channel. These flood banks are a very ancient form of flood protection and all the wide valleys in the

FIG. 6—BAGGING WORK ON RIVER TRENT

catchment area possess this type of defence. In the tidal length of the river Trent, particularly in its reach below Gainsborough, flood banks exist for the protection from tidal inundation of the adjacent lands and the numerous river Trent side villages, the average level of land being 4ft. below that of high water level of ordinary spring tides. These banks can be said to be regularly under test, which is particularly severe during gales, whereas banks subject to fluvial flood pressures are not so harassed. Apart from certain cases, it can be said that repairs to natural banks have been in the nature of first line defences to flood banks, and much work of this character has been found necessary in the Gainsborough reach, where the flood banks are practically on the natural banks.

Actual work commenced in November, 1932, with a small gang to make good those places which were deemed definitely dangerous, but it was not until 1933 that work on a larger scale was possible. By the end of March, 1934, all places where breaches seemed possible had been cleared of heavy willows and other rank vegetation growths, and thoroughly inspected for weakness; 2 miles of banks were rebuilt and raised, and over 40,000 kids, made from willows cut from the banks, were put in as staithing at the foot of the foreshore at places where local erosion had taken place. During the year 1934–35 the clearing of willows on the banks and foreshore has been completed throughout the whole length; and this very heavy work will not recur, as a light cutting every two or three years, where necessary, will suffice to keep the growth well in hand.

Particular attention has been paid to mowing the banks, which were heavily overgrown from Keadby to Trent Falls. The whole length of 53 miles to Gainsborough, with the exception of a length of 3 miles towards the mouth on the left bank, was cut twice, and in some sections where growth was very rank three cuts were necessary. The neglect of regular mowing of the banks has been one of the main causes of their deterioration; the soil has become light and friable and easily worked by rats and moles, which have caused considerable damage. Mowing at regular intervals is an essential part of future maintenance, in order to allow the turf to thicken and bind. As an accompaniment to the mowing, skilled men have been employed in catching rats and moles, and the benefit has been noticeable. In the first few weeks of the campaign large colonies of rats and over 1000 moles were destroyed. The banks are, in general, rather lower than safety requires, and during the exceptionally high tides of August and September, 1934, the gangs were called upon to raise two or three sections with emergency sacks. As in the preceding year, attention was again concentrated upon improving the banks, and men were constantly engaged in putting in staithing at weak points, and in raising and repairing the barriers.

It is, however, clear that staithing, except over very short lengths, is but a temporary measure. During the summer of 1934, when the general height of spring tides was considerably above the average, new and repaired banks, which had been protected by staithing at points where severe erosion takes place, showed signs of movement, which only the provision of several hundred tons of slag at the foot of the staithing arrested. The placing of stone at the foot of the foreshore, as near low tide level as possible, upon which a foothold for the bank can be obtained, is the only certain method of maintaining the bank in good condition over sections where slip due to erosion takes place, but this cannot yet be properly obtained until a suitable floating grab dredger is introduced for trenching below low-water mark. Where banks have been rebuilt, as distinct from "gutting" and refilling, the face has been built up with good turves and the top sown with grass seed. This has resulted in close-knit work of good appearance which consolidates quickly and is not so liable to damage by cattle. In the tidal reach above Gainsborough to Cromwell Weir, maintenance work of an important character has been continuous since the Cottam break, where, as in other cases, suitable material was unobtainable from the adjoining lands and foreshore, and it proved necessary to hire plant for dredging good clay from the bed of the river in the vicinity, no less than 3400 tons being required to fill the 60 yards of breach.

The general character of banks in the upper tidal reach differs somewhat from those in the reach below, in that the merging of the natural and flood banks is intermittent, whereas there are many miles of flood banks set well back from the foreshore. The May, 1932, and February-March, 1933, floods caused other breaches besides that at Cottam, however, where a reasonable width of foreshore existed which proved that considerable maintenance work was essential for future safety. The work has been continuous, therefore, since the floods. Where safeguarding from erosion has been necessary, the methods employed have been by staithing or concrete bagging. Flood banks have needed attention for various reasons. Below Cottam, for instance, the banks were found to be riddled with rabbits and moles, necessitating the complete reconstruction of many hundreds of yards, whilst scores of the animals have been trapped. At other places, such as Church Laneham, the material in the earthworks was found to have deteriorated into a soft friable substance through which flood waters percolated freely. Such banks have been entirely rehearted to the footings with puddled clay. At Dunham the banks were too low and also overgrown with hawthorn bushes, which were a source of continual weakness. These bushes, as elsewhere, were all grubbed up and the banks reinstated. Referring briefly to the work in the non-tidal reaches above Cromwell, the reach from Fiskerton to Farnham for 2 miles on the left bank has required much attention, the flood banks being practically eroded away for considerable lengths. Here it was not considered expedient to effect repairs on the river side, because the river is very narrow and will probably be widened in the future, but the flood banks have been considerably strengthened and enlarged on the landward side with material dredged by the Nottingham Corporation from Gunthorpe, a mutual and convenient arrangement for both authorities. At Fiskerton, a masonry wall 10ft. high supports the highway and also protects the village. The foundations of the wall were badly exposed, and collapse was imminent in several places, probably due to indiscriminate dredging for gravel and consequent slipping of the foreshore. The wall has been underpinned with concrete bagging and is now safe.

The following table sets out in summarised form all the bank and dredging works which have been completed to date :—

Flood banks reconstructed and raised ..	12 miles
New flood banks constructed	4 miles
Length of kidding of staithing	1¾ miles
Length of foreshore protected by concrete bagging (six to twelve courses)	2508 yards
Length of banks protected by steel sheet piling	102 yards
Stone pitching laid at foot of foreshore ..	700 tons
Length of river dredged and improved ..	6 miles
Length of river from which shoals have been removed by excavators	13 miles
Length of river sludged by hand	2¼ miles
Length of river from which shoals have been removed by hand	17¼ miles

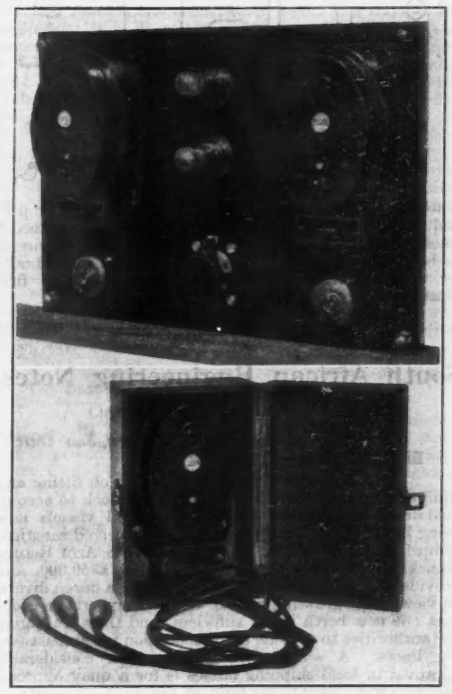
(To be continued.)

Electrical Leakage Detectors for Ships.

ANYTHING that will eliminate fire risks on ships originating from electrical leakage is obviously worthy of the attention of those whose business it is to provide the utmost safety at sea. Faults in electric wiring may, of course, also result in passengers receiving minor shocks, and although this may be a much less serious matter than the outbreak of fire, it is clearly desirable that this risk should also be removed. A common method of testing appears to be to couple a lamp between each electrical lead and the ship's frame, the wattage of the lamps being, perhaps, as low as 5. Thus, at 220 volts, the value of the leak would have to be 23 milliampères to give any real indication. But as under certain conditions, such as the presence of gaseous vapour, a leak of 1 milliampère may cause a flash and result in a fire, this method of testing cannot be regarded as satisfactory.

Leakage Detectors, Ltd., of 68, Victoria-street, S.W.1, have therefore designed an instrument that will detect a leak of 1 milliampère. It is suitable for wall or panel mounting, and as the casing is made of highly compressed synthetic resin, it is claimed to resist sea-going conditions. Warning of electrical leakage is given by a neon lamp red glow, which appears in a glass-covered aperture about 1½in. in diameter. By means of a selector switch it is possible to set the instrument while it is in service to operate at any desired value of leakage, whilst by means of press buttons, indicated in the diagram, the instrument itself can be tested at any time, the illumination of the neon tube indicating that the detector is in order. The instrument is completely sealed and the internal parts are solidly sunk in bitumen so that they cannot be tampered with.

Fires on ships that have been traced to faulty cables may have been due in part to the higher voltages now in vogue. Much of the auxiliary wiring is run behind wooden bulkheads and wooden beading, when even a small leak is a potential source of danger. The cargo carried even in passenger ships is often of an inflammable nature, and a leak of, say, 3 milliampères may be sufficient to cause a fire. It has been found that it is possible to light the special type of neon tube used in these instruments with a very high resistance in series, and difficulty was experienced in cutting off the light with the aid of resistances. It was eventually



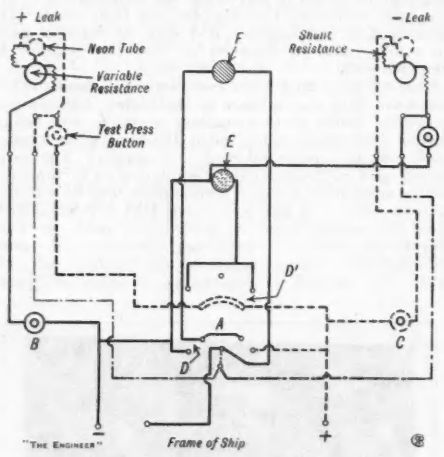
LEAKAGE DETECTORS: PANEL MOUNTED AND PORTABLE

found, however, that with a special arrangement of shunt and series resistances, shown in the diagram, it was possible within limits to cut in or cut out the light with the degree of leakage desired, and to vary the degree of sensitivity of the instrument while it is in action. When working with direct current it was found that the tube would operate much better and was more susceptible to control when coupled to the positive pole in a particular way, and with the series resistance connected on the negat ve side. Even when subjected to the full voltage the total amount of current passing through the instrument is only 0·35 milliampère, and this current scarcely varies with a leakage, say, from 2 milliampères to that corresponding to a "dead short."

Assuming a D.C. fully insulated, 220-volt supply, two instruments are used, as shown in the first illustration, one for showing the positive leakage, the other the negative leakage. They are coupled in circuit at any desired point, such as at the chief engineer's office. In the event of a leak from the positive pole to the ship's frame, current will flow *viâ* the various resistances and neon tube to the negative wire, and will not affect the right-hand instrument. If, on the other hand, the leak is from the negative main, the right-hand instrument comes into operation. In the event of a leak, the master detectors will immediately give warning, and if the leakage current exceeds the safe value, tests must be made to check the source. This can be done by opening circuit switches and by testing with a megger, but much time can be saved by employing a leakage detector for each switchboard. Although it may be impossible to draw the switch of the electric steering gear if, by testing all other circuits, no fault is found, it may be assumed that the untested circuit is at fault. As an alternative to the practice of installing a circuit detector for each switchboard to indicate the actual source of leakage, a portable instrument, as shown in the second illustration, may be used for sub-circuit testing.

The positive and negative bus-bars are connected to the master panel terminals + and —, shown in the diagram, and a lead from the ship's frame is connected to the remaining terminal. If the centre switch A is placed in the vertical position, shown dotted, and the tumbler switches B and C are closed, indication of a leak will be given by one of the neon tubes. If the left-hand

tube operates the leak is on the positive side, whilst if the right-hand tube gives an indication it is on the negative side. By isolating each circuit in turn on the main switchboard and by observing which of the circuits isolated gives rise to failure of the light, the faulty main circuit is readily found. To test for a positive leak in a sub-circuit the switch on the faulty main is closed, and the switch A on the detector panel is turned in a clockwise direction to the limit of its travel D. As the switch has fixed upper and lower contacts insulated from each other, it will be seen that from an inspection of the diagram that the operation causes the red lamp to light by establishing connections at D^1 and D, thus giving warning that the panel is being used for tracing faults, and that for the time being it is incapable of giving the usual indication. With the switch in the position stated, current flows from the positive terminal across D^1 through the lamp



CIRCUIT DIAGRAM OF LEAKAGE DETECTOR

E to D and to the ship's frame *viâ* the resistance lamp F, and, at the same time, the negative pole is "earthed." Each parallel and independent circuit in the sub-circuit to be tested is selected in turn, and tested individually by the portable instrument shown in the first illustration.

South African Engineering Notes.

(By our South African Correspondent.)

CAPE TOWN, Jan. 15th.

Big Dock Plans.

AT Cape Town work is beginning on fitting and equipping a deep-water berth in the new dock to accommodate the 25,000-ton Union-Castle mail vessels now being built. The work, which has just received sanction, comprises a quay 900ft. long at the South Arm Return Knuckle, and it is estimated it will cost £350,000, and provide work for about 500 men, including a dozen divers. In view of the growing trade of the port, experts consider that one new berth is not sufficient, and they are urging the authorities to provide accommodation for at least two big liners. A scheme that meets with considerable approval in local shipping circles is for a quay approximately 1600ft. long to be built at the inner extremity of the new dock, running approximately north and south, or head on to the prevailing winds. It is urged that such a quay would allow greater manœuvring space for the mail steamers entering the docks in strong winds, whereas with the single berth that is about to be built it will mean a sharp turn at the entrance. Within the last twelve months the size of ships using Table Bay Harbour has increased considerably. These include the two Italian express liners, the lengthened and improved Holland Africa motor passenger and cargo vessels, the vessels which a new Belgian company is going to put on the Europe–South African route, the lengthened and improved German liners, and others, beside which at least four luxury tourist ships of 20,000 tons or thereabouts are arriving here during the early part of this year. In addition to the new quay, the present scheme for Cape Town includes a cold storage, which will be the largest of its kind in the world, and will cost approximately £275,000. At East London the Government has decided to spend a further £250,000 in lengthening the breakwater, lengthening quay, and various other facilities which were asked for some time ago.

A New Railway Commission.

A South African Railways and Harbours Service Commission has been established for the purpose of making recommendations for the filling of posts in the railway service, subject to regulations approved by the Governor-General, a summary of which is given below. The Commission will consist of three members appointed by the Governor-General, one of whom shall be the Chairman of the Union Public Service Commission, who will be Chairman of the new Commission; while the other two members will be appointed from officers in the railway service. Mr. Graham Cross, Chairman of the Public Service Commission, is therefore Chairman of the Railway Service Commission, and Lieut.-Colonel Allan Herschell, system manager at Durban, and Mr. C. G. C. Rocher, assistant chief civil engineer at Johannesburg, are the members of the Commission. These appointments are for a period of five years from January 1st, 1935. Under the new regulations, the Minister of Railways may appoint to permanent employment and increase the emoluments of an officer, the maximum salary of whose appointment does not exceed £2000. The General Manager has power to deal with appointments up to a maximum salary of £1500, subject to his being in agreement with the recommendation of the new Commission. In the event of disagreement, the matter will be referred to the Minister. Appointments carrying salaries of over £2000 per annum rest upon the decision of the Governor-General.

More Electricity for Johannesburg.

The Johannesburg City Council is going to spend £144,000 for extensions to its power station, and application is to be made to the Administrator for borrowing power to meet this expenditure. The proposed extensions comprise a 15,000-kW turbo-alternator and boilers, which, under the scheme drawn up in 1932, were forecast to be required in 1942. Since 1932, however, states the report of the Lighting Committee, the rate of increase in the demand for power has been phenomenal. The maximum supply during the winter of 1934 was 45,000 kW,; the average increase in the peak demand during the past four years was 4300 kW annually. The peak demand for 1935 is expected to be 49,000 kW and for 1936 52,000 kW. The Committee considers further that this estimate is very conservative in face of the great activity and expansion now taking place in the city and the ever-growing demand for electricity. To be able to meet the expected demand in 1935 it is considered that the Administrator's sanction to proceed with the extension should be obtained as early as possible. Anticipating, apparently, a favourable reply from the Administrator of the Transvaal Province, the Lighting Committee has already obtained tenders for the required additions, and has recommended that the tender of C. A. Parsons and Co., Ltd., of £33,622 for the steam turbo-alternator, switchgear, condenser, &c., and the tender of Reynolds, Sons and Partners (Pty.), Ltd., for the supply, delivery, and erection of the boiler unit, mechanical draught plant, extensions to steam and feed water pipes, &c., at the price of £24,655.

Improved Railway Figures.

The figures published in the annual report of the General Manager of Railways and Harbours for the financial year ended March 31st, 1934, show that the majority of passengers on the railways during the financial year travelled third-class. Out of the total of 75,757,264 passengers, 27,539,532 travelled third. First-class passengers came next, with a total of 25,515,948, and second-class passengers 1st with 22,702,284. The total of passengers during the financial year showed an increase over the figure for the previous financial year of nearly 6,000,000. The reason for the large number of first-class passengers is probably to be found in the fact that over 65,000,000 of the total passengers made their journeys on the suburban services in the various big centres of the Union. For that part of the financial year commencing April 1st, 1934, and up to December 29th, the railway earnings of the railways have exceeded £20,000,000, compared with just over £17,500,000 for the corresponding period of 1933–34. The two weeks ended December 15th and December 22nd had record totals. For the week ended December 15th the total earned by the railways was £583,475, which surpassed all previous records, but this was beaten in the very next week, when the total was £590,511. The total for the corresponding week of 1933 was £522,197.

Increase of Air Travel.

Air travel in South Africa has become more popular since the arrival of the three 17-seater Junkers machines at the beginning of last month. Since the Government took over the Union Airways in February, 1623 passengers have been carried on the main air services. Of this number, 544 have made use of the new machines during November and December. In December 283 passengers were carried. The previous highest total was in May, when 171 passengers were carried. During that month, however, there was a daily service between Durban and Johannesburg, whereas during the past two months the Rand service has only been operated on four days each week. Between February and the end of October the monthly average was 119. when the smaller planes were in use. Since February the S.A. Airways made 833 flights; machine miles flown, 279,392; hours flown, 2267; mails carried, 26,095 lb.; goods (luggage) carried, 43,483 lb.; freight, 15,625 lb. The average speed maintained was approximately 123 m.p.h. Ten new spare engines for the giant Junkers air liners are at present on their way out from Germany. It is expected that they will be off-loaded at Durban about the middle of this month. Two spare engines have already arrived. The engines will be used in rotation on the machines, so as to prevent more than two engines falling due for overhaul at the same time. It is learned that the mechanical staff at Stamford Hill aerodrome is to be augmented as from January with an additional four fully qualified engineers. At present there are nine engineers, two learners, and one inspector. The four new men will be taken from Johannesburg.

New Fighting Planes.

The S.A. Air Force workshops are busy now building forty Aero Tutor machines for cadet instruction purposes, but as soon as two S.A. Air Force officers, who have been overseas, return, work will be started on forty Hawker machines. The Defence Department recently bought seven single-seater Hawker Furies. These are capable of travelling at 240 m.p.h. The Department has also purchased from the Hawker Aircraft Works two two-seater fighters, and two armoured fighters. All these planes will be delivered in April.

Bloemfontein Locomotive Record.

The complete overhauling of a standard locomotive in five days is the fine achievement claimed by the Bloemfontein railway workshops. In local railway circles this is believed to be a world record. In any case, it is a record for South Africa. The standing world record is stated to be six days. In view of the performance, the opinion of the Granet Commission may be quoted. That Railway Commission when in the country recently inspecting the South African railway system, expressed the opinion that the Bloemfontein workshops, with the present staffing and repair facilities, should be able to overhaul an engine in from thirty to thirty-five days. Last month ten engines were turned out at these workshops at an average of fourteen days each. The fast time of turning out an engine in five days was established with the definite object of breaking the record. The high speed of the production is attributed to the highly efficient organisation of the local mechanical workshops.

First Trains in Cape Province.

The first trains on the Cape Town–Wynberg Railway started running on December 19th, seventy years ago. With the exception of a short line in Natal, a purely local one to the harbour at Durban, and the Cape Town–Wellington line, which started a year before the Wynberg railway was opened to traffic, it was the first railway to operate in South Africa. There was a dispute between the Cape Town–Wellington Railway Company and the Cape Town–Wynberg Railway Company at the outset, the first line, which was financed from England, refusing running powers over a short stretch of track from the Cape Town Station to a point beyond the Castle, but after a struggle the Wynberg line managed to get a Bill through Parliament giving it the rights required. But although successful in this, the Wynberg Company found it desirable to lease its railway to the Wellington concern. It was leased on March 6th, 1865, for ten years, at a rent of £3700, plus a further £300 a year for fire risks. In the following year the Wynberg line paid a dividend of 5 per cent., and in 1868 one share was sold in Cape Town for £5. The new line became popular. On January 1st, 1865, 2400 passengers left Parade Station (Cape Town) for Wynberg, and about 1000 for intermediate stations. Mr. Watson, an official, and the traffic manager, Mr. Dell, rode on the locomotive and took tickets at Mowbray and Claremont stops. Now the daily average of passengers on the suburban lines from Cape Town, through Wynberg to the terminus at Simonstown is 93,000, and the S.A.R. Blue Book, published on December 19th, gives the total for the last financial year as 34,241,561.

New Sheet Mill.

The new sheet mill plant at the iron and steel works at Pretoria West is practically completed, and is scheduled to begin operations early in February. The new plant will be worked by several hundred men, a proportion of whom will be South African. Naturally, the skilled positions will be held at first by trained men from abroad, who will teach the local workers the intricacies of sheet mill work. The imported men are coming out on three years' contracts.

New Electrified Line Opening.

The first full service on the newly electrified line between Ladysmith and Harrismith will come into operation on February 4th. At the moment the overhead equipment is ready for use, but as several sub-stations have still to be completed, the line will not be tested until January 28th. Between that date and February 4th numerous test runs will be made, the line being officially opened when the first train of the normal service passes over it.

Machinery for the Mines.

The tremendous strides made by the mining industry during the past year are reflected in the heavy importations of machinery destined for the mines. The port of Durban during the last few months has been handling more material for the Rand mines than has been the case for many years; indeed, it is very doubtful if the amount, both tonnage and value, has ever been equalled in a like period in the past.

Durban-Cato Bridge Electrification.

£390,000 will be spent on the electrification of the Natal main line between Durban and Cato Bridge during the next twelve months. Work on this scheme was commenced on January 14th. The expenditure will cover the provision of thirteen new units at £10,000 each, five new sub-stations at an inclusive cost of £70,000, and the erection of 70 miles of 88,000-volt transmitting lines at £60,000. It is estimated the scheme will save £50,000 annually in operating costs, and thirty-one steam locomotives, valued at £200,000, will be set free for use on other systems in the Union.

East London Turning Basin.

On Sunday morning, January 13th, 1935, water was let into the new main turning basin excavation in the Buffalo Harbour, East London, flooding the area in which the mail boats will be accommodated. The cost of the new basin has been £250,000. An extension of the basin for 500ft. towards the sea entrance of the river has recently been sanctioned, and will be commenced at once.

ERRATUM.—"Development of Parsons Industrial Turbo Machinery," February 1st, 1935, on page 117, third column, twenty-first line from foot, for Mr. T. B. Rogers, read Mr. T. B. Rogerson.

INSTITUTION OF CIVIL ENGINEERS.—The fiftieth anniversary of the Manchester and District Association of the Institution of Civil Engineers was celebrated at the annual dinner, which was held on Wednesday, January 30th, at the Midland Hotel, Manchester. Mr. J. Harcourt Williams, Chairman of the Association, presided, and the principal guest was Sir Richard Redmayne, President of the Institution. A student member, Mr. J. L. Matheson, proposed the toast of "The Institution," and this was responded to by the President. The toast of "The Cities of Manchester and Salford" was proposed by Principal B. Mouat Jones, and the Lord Mayor, Alderman S. Woollam, who replied, made reference to a proposed underground railway for Manchester. He said this would be a great engineering feat, which he and his colleagues on the City Council were anxious to see accomplished. He thought that if civil engineers could devise a scheme of that kind which would attract capitalists to invest in it would be the means of solving the traffic problem in Manchester. The Mayor of Salford also responded to the toast. The toast of "The Manchester and District Association" was proposed by Mr. J. R. Adamson, President of the Manchester Society of Architects, and acknowledged by Mr. J. Harcourt Williams.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

International Agreements.

At the last meeting of the European Steel Cartel some interesting subjects were discussed and it was announced that negotiations would be opened again between the Cartel and Great Britain. According to rumour, however, the correspondence between the parties does not indicate a very favourable outcome to the proceedings. On the Continent it has been repeatedly stated that the ship plate agreement would not be extended after January 31st unless the general question of the relations of the British steel makers and the Cartel were settled by then. Similarly, the Continental steel works, it was said, would not renew the International Rail Makers' Association, known as I.R.M.A., of which the American steel industry is also a member, unless it received a satisfactory quota in the British market. Some doubt, however, was expressed as to whether the Continent would go to such lengths, and it now transpires that the ship plate agreement is to be continued indefinitely. It is evident, therefore, that the arrangement has proved too useful to the signatories to be allowed to go by the board. I.R.M.A. also is an association that has had a somewhat stormy career, and on more than one occasion in the past its existence has seemed to be threatened. Probably history will repeat itself and when the time for renewal comes at the end of March the agreement will again be signed. March 31st will be a somewhat important date in the Continental steel trade calendar, since on that day the Tube Syndicate agreement also has to be renewed. The international tin-plate arrangement has been attacked by a section of the merchants lately, but this does not seem to have affected its stability, and it has been announced that the Norwegian tin-plate works have become members. As these do not export, they have probably joined the organisation in order to maintain prices in their home market. On the other hand, the domestic affairs of the Continental Steel Cartel continue to cause concern to members, largely owing to the favourable position into which the German steel makers have manœuvred themselves. The latest report is that the latter have refused to consider the organisation of further overseas markets on the lines which have been proposed by the Cartel since it does not give them scope for indulging in their favourite barter arrangements.

The Pig Iron Market.

Although the amount of new business reaching the producers is rather on the light side, there are indications that the demand is on the point of expanding. A good feature of the situation is that the consuming industries in the Midlands and the North are becoming increasingly busy, and are taking important deliveries of pig iron. In most districts during the past week or two additions have been made to stocks, as the amount of fresh business coming forward has not been sufficient fully to absorb the make. In view of the anticipations with which the year opened this has been somewhat disappointing to the industry, but from the way things are now shaping the principal users should soon be requiring additional supplies of iron. On the North-East Coast some relief is felt at the improvement in the deliveries to Scotland, which may now be regarded as having reached their normal tonnages after an unexpected period of dullness. The volume of export trade has not been maintained, but makers are not at all keen upon accepting the low prices which are necessitated by foreign competition in overseas markets. The local consumers on the North-East Coast have taken good quantities of late; but new business has been limited to small orders, as most of the consuming works have covered their supplies for some time ahead. The Midland market has shown rather more life, although it has not yet reached the stage of activity for which the trade hoped a few weeks ago. Deliveries, however, have expanded to a considerable extent lately, and inquiry has improved both as regards number and tonnage. Much depends in this district upon the rate of activity at the light castings works, and this seems to be gradually accelerating as the demand for building materials improves with the season. The quantities of forge iron passing into consumption leave much to be desired. The Scottish pig iron market is rather apathetic, but deliveries against contracts appear to be sufficient to avoid additions to the stocks. Twelve furnaces are in operation in Scotland, of which two are making basic, four hematite, and six foundry. The North-East Coast makers are finding the demand steady, and recently there has been some buying for delivery up to the end of the first quarter. The local works are taking about 50 per cent. of the production, but some good business has been done recently with South Wales and Scotland.

The North-East Coast and Yorkshire.

The chief feature of the market for finished steel materials is its irregularity. Since the New Year the demand, generally speaking, has been rather quiet, and not only has it fluctuated to a greater extent than usual, but whilst some departments have been on the whole well supplied with orders, others have experienced a dearth of new business. The position, however, has not at any time given cause for anxiety, since practically all the makers have had a considerable reserve of orders on their books, and deliveries have been at a satisfactory rate. Practically all the North-East Coast steel works are busy, and in some departments have well-filled order books. There is a steady flow of orders for structural steel, and as the prospects of the constructional engineering industry seem to be excellent, there is little likelihood of a diminution in the demand. A large tonnage of railway material is being turned out by the works on this coast, and fresh orders are expected from the London and North-Eastern Railway. Some improvement is reported in the sheet market, but the makers are not well off for orders and lately have been pressing for business. The requirements of overseas markets have failed to expand sufficiently to keep the sheet mills in steady employment. Business in plates has improved lately and the outlook is better than for some weeks, as old contracts are approaching completion and will probably have to be renewed. More orders have come to hand recently for semis, the possibility of an increase in the duties on this class of material having stimulated buying by some British consumers. The Yorkshire steel industry is working under satisfactory conditions. Order books are well filled, and the Sheffield section of the trade, in particular, is in a good position. The record output of basic steel is being maintained, but quiet conditions rule in the acid steel department. The demand for special steels tends to improve, and the requirements of users of these descriptions continue to expand.

The Midlands and South Wales.

The position of the Midland steel industry is regarded with confidence, although at the moment the volume of new business reaching the works is not more than sufficient to keep pace with the orders which are worked off. This, however, is not an unusual condition at this period of the year, when many of the consuming trades experience a seasonal slackening in activity. The constructional engineering industry is one of the busiest sections in the district, partly owing to the considerable amount of factory building and reconstruction and extensions to workshops. A number of important contracts are also in hand for municipalities and large corporations, and together these provide an outlet for a considerable tonnage of joists and sections. Steel makers say, however, that the new business coming in scarcely reflects the amount of work the constructional engineers have in hand and put this down to their having adopted a policy of covering their requirements only as the need arises. The sheet makers have recently experienced a better demand from home consumers, but the export side of this trade is distinctly quiet, and as a result the mills are not busy. Business in the lighter gauges of plates has been rather brisk of late, and the tank and boilermakers have placed a fair tonnage of orders. The improvement in the request for the latter description is only comparative, and many users have arranged for their supplies for some time to come at the present rate of consumption. For the time being there is a lull in business in small steel bars and buyers appear to be taking stock of the position now that the question of raising the duties on this material will be considered by the Imports Duties Advisory Committee. One result is that buyers do not care to place fresh orders unless early shipment can be guaranteed. On the other hand, sellers frequently require an understanding that any duty above the existing rate shall be to buyers' account. There is an active demand for bright-drawn steel at £13 10s. basis. The collieries continue to take good quantities of steel, but as most users have arranged for their supplies for the next month or two new business is rather quiet. In South Wales trading in the iron and steel market runs on steady lines. The tin-plate works have good order books, but are finding specifications rather difficult to obtain. The export demand also has been rather quiet. As a result of these conditions the output quota of the industry has been reduced to 55 per cent. from 75 per cent. of capacity.

Current Business.

The Admiralty has allocated the contracts for its 1934 programme, subject to the settling of certain details, in the following way:—Hull and machinery for H.M. submarine "Spearfish" to Cammell Laird and Co., Ltd., of Birkenhead; machinery for H.M.S. "Aurora" to the Wallsend Slipway and Engineering Company, Ltd., of Wallsend. The "Aurora" is to be constructed at Portsmouth. It is reported that the North British Locomotive Works at Springburn have secured an order for twenty locomotives for the London and North-Eastern Railway. Arcos, Ltd., announce that negotiations have been completed for placing orders for machinery and equipment in this country amounting to one million pounds on a cash basis for the Soviet. The orders given out in January included contracts totalling £500,000 for railway wheels, axles and tires. Together, the orders involve the use of 55,000 tons of steel. Hughes, Bolckow Shipbreaking Company, Ltd., of Blyth, have bought the Phœnix Works, Stockton-on-Tees, of Worth, Mackenzie and Co., Ltd. These include a foundry, a pump-manufacturing department, and an engineering shop. The Department of Overseas Trade announces that the following contracts are open for tender:—South African Railways and Harbours: Flat and round spring steel (Johannesburg, March 4th); single and duplex vacuum gauges and steam pressure gauges (Johannesburg, March 18th). Argentine State Oilfields Directorate: 400 brass tubes, outside diameter 25 mm., inside 21 mm., length 6100 mm.; 300 naval brass tubes, outside diameter 15·875 mm., inside diameter 13·875 mm., thickness 1 mm., length 3048 mm. (Buenos Aires, March 6th); twelve 200 h.p., sixteen 35 h.p., twenty-six 20 h.p., and twenty 70 h.p. three-phase asynchronous motors, with controllers and starting resistances (Buenos Aires, February 27th). Indian Stores Department: One cold-starting, crude-oil engine-driven vertical spindle, tube well turbine pump, capacity 12,500 imperial gallons per hour (New Delhi, February 27th). Siam, Royal State Railways: Steel superheater tubes and elements (Bangkok, April 5th). Brisbane City Council: Twelve panels of 11,000-volt, metal-clad switchgear, seven panels of 415-volt, truck-type switchgear, one 500 kVA transformer, and two 2850 kVA banks of metal-clad reactors (Brisbane, April 28th).

Copper and Tin.

The electrolytic copper market has been affected by outside influences to a greater extent probably than appears upon the surface. It is always recognised that this market is sensitive to extraneous conditions, and the disturbance created in other commodity markets by the trouble resulting from operations in grain and pepper, as well as by the decision of the United States Supreme Court to defer its judgment on the gold clause, has been more than sufficient to upset confidence in the copper market. A certain amount of business has been transacted with consumers, although the tendency has been for them to buy small parcels as the need arises. It is believed that there are still large quantities of copper lying at the consuming works on the Continent, which, by arrangement with the producers, are taken and used at the current price as required. This, of course, reduces the amount of business which comes on the open market. Lately French consumers have shown more interest in the metal, but the German position is difficult and unsatisfactory. The Government endeavours to force its nationals to secure copper by barter, but these transactions are not easily arranged, and although some German consumers have secured supplies the majority seem to be working on small stocks. The tone of the standard market has been rather weak, and there is no doubt that it is in a somewhat nervous state from the causes just referred to. American producers continue to sell good quantities of electrolytic, and this naturally has had the effect of keeping the price low. . . . A feature of the tin market has been the increase in the backwardation which recently touched £5, and later receded to £4 10s. It is suggested that the international control is squeezing those who have sold short, although it is pointed out that the Buffer Pool was provided in order to relieve the situation if the shortage of metal required by the market became acute. It has been asserted that the squeeze is enabling the "Control" to make profits with which to finance its stocks, although, at the same time, it checks the development of legitimate trading on the Metal Exchange. The monthly figures were rather disappointing. Mr. Gartsen's statistics showed an increase of 648 tons in the visible supply, which was due to an increase in supplies of 1939 tons and a decline in deliveries of 529 tons.

The Lead Market.

Conditions in the lead market have scarcely changed over the week. Transactions have been of little importance and the tone of the market has been colourless. In the United States consumers are reported to be taking only limited quantities and the Continental trade has been poor. A slight backwardation developed in the market last week, but this frequently occurs at the end of the month. A consignment of Mexican lead is expected to reach this country early in February, but little is heard of supplies of Empire metal and the premium remains at 15s. to 17s. 6d. on prompt duty-free lead. It has been announced that a contract has been entered into between the Greek Government and Thracian Mineral Product, Ltd., London, by which the latter will establish a plant at Laurium within two years with an annual productive capacity of 30,000 metric tons of lead ore and a minimum capacity of 5000 tons of lead pigments. The company may also include in its activities copper products, for which the ore must be obtained from mines in Greece.

Non-ferrous Metal Average Prices.

For the first time for many months the London Metal Exchange official average prices show increases in all departments. The upward movement has been unimportant in each case, and ranges from a few shillings to a few pence; but it is satisfactory as showing a better tendency. The official average price for cash copper for January increased by 4s. 8d. over the December average, and that for three months by 4s. 1d., the average for electrolytic copper being 2s. 9d. over the previous month, and that for wire bars 1s. 11d. For best selected copper the average was 1s. 10½d. higher. In the tin market the movement was chiefly noticeable in the case of cash tin, this being due to the backwardation which ruled during the greater part of January. The average price for cash increased by £3 0s. 11d., but for three months' tin the average was only 5s. 2d. better than the December figure. In the lead market prices varied so little that the official average for shipment during the current month, shipment during the third following month and the mean were only 2d. higher in the first instance and 3d. for the last two. The average quotations for spelter for January indicated a rather more pronounced upward movement, the average for shipment in the current month being 5s. 3d. over the December average, and for shipment the third following month 3s. 10d. higher, the mean registering an advance of 4s. 7d. The following are the official average quotations for January:—

		£	s.	d.
Standard Copper	Cash	£28	2	2 41/42
	3 Months	£28	9	5 13/42
	Settlement	£28	2	4 7/11
Electrolytic Copper		£31	9	1 1/11
Electrolytic Wire Bars		£31	12	11 1/11
Best Selected Copper		£31	2	6
Standard Tin	Cash	£231	6	0 3/11
	3 Months	£228	16	9 1/11
	Settlement	£231	6	4 4/11
Lead	For shipment the current month	£10	6	5 3/22
	For shipment the third following month	£10	10	3 3/22
	Mean	£10	8	4 5/22
	Settlement	£10	6	7 4/11
Spelter	For shipment the current month	£11	19	10 7/11
	For shipment the third following month	£12	4	1 1/2
	Mean	£12	2	0 23/44
	Settlement	£12	0	0

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.: plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/- rebate*)	3 7 6	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/- rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/- rebate*)	3 7 6	—
N.W. Coast—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 0	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	—
Flats, 5in. and under	8 14 6	7 2 6
Plates, ¾in. (basis)	9 0 0	7 15 0
„ ⅞in.	9 5 0	8 0 0
„ 1in.	9 10 0	8 5 0
„ 1⅛in.	9 15 0	8 10 0
„ 1¼in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¾in.	8 15 0	7 15 0
„ ⅞in.	9 0 0	8 0 0
„ 1in.	9 5 0	8 5 0
„ 1⅛in.	9 10 0	8 10 0
„ 1¼in.	9 5 0	8 5 0
Boiler Plates, ¾in.	9 5 0	8 5 0
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅞in.	9 2 6	8 0 0
„ 1in.	9 7 6	8 5 0
„ 1⅛in.	9 12 6	8 10 0
„ 1¼in.	9 5 0	8 5 0
Boiler Plates, ¾in.	9 7 6 .. 7 15 0 to	8 5 0

STEEL (*continued*).

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 15 0	7 15 0
„ ⅞in.	9 0 0	8 0 0
„ 1in.	9 5 0	8 5 0
„ 1⅛in.	9 10 0	8 10 0
„ 1¼in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅞in.	9 2 6	8 0 0
„ 1in.	9 7 6	8 5 0
„ 1⅛in.	9 12 6	8 10 0
„ 1¼in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¾in. (basis)	9 0 0	9 2 6
„ ⅞in.	9 5 0	9 7 6
„ 1in.	9 10 0	9 12 6
„ 1⅛in.	9 15 0	9 17 6
„ 1¼in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2 to 19/2.

Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/- per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 12 6	7/-
„ „ 8 p.c. to 10 p.c.	£21 12 6	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/-
„ „ „ 1 p.c. carbon	£38 15 0	12/-
„ „ „ 0·70 p.c. carbon	£42 0 0	12/6
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 19 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Ferro Cobalt	5/3d. per lb.	

NON-FERROUS METALS.

Official Prices, February 6th.

Copper—	
Cash	£27 2 6 to £27 3 9
Three months	£27 7 6 to £27 8 9
Electrolytic	£30 5 0 to £30 10 0
Best Selected Ingots, d/d Birmingham	£31 0 0
Sheets, Hot Rolled	£58 0 0
	Home. Export.
Tubes, Solid Drawn (basis)	9½d. 9½d.
„ Brazed (basis)	9½d. 9½d.
Brass—	
Ingots, 70/30, d/d Birmingham	£27 0 0 to £29 0 0
	Home. Export.
Tubes, Solid Drawn, 2/1 Alloy	8¾d. 8¾d.
„ Brazed	10¾d. 10¾d.
Tin—	
Cash	£232 15 0 to £233 0 0
Three months	£228 17 6 to £229 0 0
Lead	£10 1 3 to £10 6 3
Spelter	£11 15 0 to £12 0 0
Aluminium Ingots (British)	£100

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
f.o.b. Grangemouth)—Navigation Unscreened	13/- to 13/6
„ Glasgow—Ell	16/6
„ „ Splint	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	14/- to 14/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Prime Steam	14/-
Unscreened Navigation	12/6 to 13/-
Lothians—	
(f.o.b. Leith)—Hartley Prime	14/- to 14/6
Secondary Steam	13/6

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/- to 17/6
Northumberland, Newcastle—	
Blyth Best	14/6 to 14/9
„ Second	13/3
„ Best Small	10/6 to 11/-
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/8
Foundry Coke	18/6 to 22/6

Sheffield—	Inland.	
Best Hand-picked Branch	24/- to 26/-	—
South Yorkshire Best	21/- to 23/-	—
South Yorkshire Seconds	17/6 to 19/-	—
Rough Slacks	8/- to 9/-	—
Nutty Slacks	7/- to 8/6	—

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/-
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 26/-
Foundry Coke	24/- to 37/6
Furnace Coke	19/- to 21/6
Patent Fuel	21/-
Swansea—	
Anthracite Coals:	
Best Large	37/6 to 40/-
Machine-made Cobbles	41/- to 51/-
Nuts	40/- to 50/-
Beans	25/- to 30/-
Peas	19/- to 22/6
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large	18/- to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Motor Car Industry.

THE attempt to refloat the Citroën Company may have a repercussion on the motor car industry if it be found that the success of the plan to reorganise the concern in a manner to meet the requirements of financial interests is dependent on other makers adopting the proposed methods of restriction. A plan is being prepared, and may be submitted to other motor car firms, whereby stress is laid first on the necessity of reviving confidence by adhering strictly to contracts and adopting sound business methods. Then production will be limited to requirements based upon the estimates of agents and salesmen who are in direct contact with customers. Output will not be expanded beyond needs for reasons of personal ambition. By reducing the number of models and stabilising them for some years it is hoped to avoid the depreciation of cars by the frequent introduction of new types. When improvements are necessitated by technical progress or by customers' requirements they must be adopted in a manner to alter as little as possible the external appearance of cars. In this way cars will preserve a certain uniformity for long periods and thereby encourage business amongst customers, who will not suffer from a rapid depreciation of their purchases. Whether or not this plan will receive general approval, it at least indicates a new trend of the motor car industry, which, it is argued, needs to be placed on a more stable basis, particularly by limiting the competitive introduction of new motor car types and lessening the liability to car depreciation by a more gradual adaptation of technical progress.

Employers and Unemployed.

The decree determining the conditions under which employers are entitled to premiums for taking on men in receipt of relief has been published. It shows a desire to avoid pitfalls which proved fatal to similar attempts in other countries to absorb the unemployed in their respective trades. The premium will only be paid in cases where the taking on of unemployed workers brings the total number of hands to above the average number employed during the corresponding three months of the previous year and of the three months preceding the demand for unemployed men; that is to say, six months altogether. The premium will be equivalent to the amount otherwise paid for relief. The idea of imposing this condition is to meet objections to the effect that the premium would introduce an unfair element of competition by enabling some employers to make more use of cheap labour than others. From the wording of the decree it does not appear that this risk is altogether eliminated. The success of the plan will depend upon whether it will give satisfaction to the majority of employers. In the same way, there was a good deal of criticism over the proposal to introduce short time, which is found to be quite impracticable in industries depending upon seasonable and fluctuating demands, and in the Bill which the Government has prepared the application of short time will only be rendered compulsory when required by the majority of manufacturers in a specified industry in a particular district.

The Paris Fair.

The committee of the Paris Fair believes that commercial exchanges between countries can be developed by more intimate relations between international and national Fairs, and at the forthcoming British Industries Fair a group of French exhibitors at the Paris Fair will make a "friendly and sympathetic visit," for while they are precluded from showing their products at the British gathering, they are of the opinion that these personal contacts will do much to help a revival of foreign trade. The committee of the Paris Fair, moreover, calls attention to facilities provided at its offices in London for obtaining information concerning the products of French exhibitors in Paris. The same feeling of cordial relations between the Fairs was observable at the recent banquet in Paris in connection with the forthcoming British Industries Fair. A closer contact between manufacturers of the two countries will do more than anything else to encourage business by showing what each can supply without detriment to the other and, at the same time, removing competitive fears which are the chief obstacle to trade. Notwithstanding the unsatisfactory economic situation in France at the present time, the Paris Fair will be well supported, but the engineering section will lose much of its interest through the abstention of French manufacturers and importers of machine tools.

The Navy Speed Record.

The destroyer "Le Terrible" attained a speed in her trials off Lorient last week of 45·05 knots, which is 2 knots better than the previous record set up by the "Cassard" in October, 1933. She is the first of a series of destroyers of an identical type. Two others constructed in the dockyards, "Le Fantasque" and "L'Audacieux," failed in their preliminary runs to show anything like the same speed, a fact that is strongly emphasised by shipbuilders as a reply to the Government's abortive attempt to suppress the small shipyards. "Le Terrible" was built in the Blainville Yard, near Caen, of the Chantiers Navals Français, which was included in the list of shipyards to be deprived of State orders by the decree that has since been withdrawn. The "Terrible" has a length of 125·4 m. and a width of 11·98 m., with a displacement of 2569 tons. The turbines develop 74,000 h.p. She has five guns of 138 mm., four anti-aircraft guns, and three triple torpedo tubes.

Mediterranean Liner.

The first of the two ships which are to improve and accelerate the service between Marseilles and Algiers was launched at Saint-Nazaire this week. The "Ville d'Alger" is an 8820-ton ship, which will steam at more than 20 knots and cross the Mediterranean in less than twenty hours. Resembling big liners in design, she will have accommodation for more than 1000 passengers in four classes.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

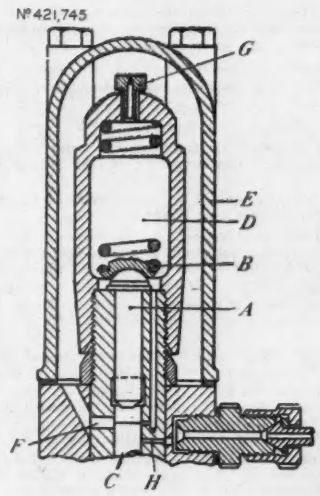
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

421,745. July 20th, 1933.—OIL FUEL INJECTION PUMPS, B. Bischof, Tobelstrasse 16, Winterthur, Switzerland.

In this fuel pump the head of the barrel is closed by a plunger A, which is held down by a powerful spring B. The working piston is shown at C. Above the plunger A there is a compression chamber D, which is enclosed by a casing E common to all the pumps of the engine. This casing communicates with the fuel oil tank and has inlets F to each of the pumps. The compression chamber D communicates with the casing E through a restricted orifice G. On the delivery stroke of the piston C,

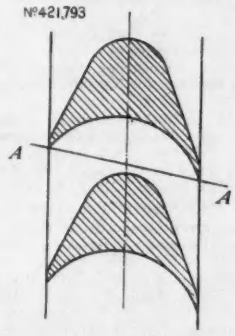


after it has passed the inlet port F, the entrapped oil is compressed against the plunger A until an axial port and circumferential groove in the piston come opposite the delivery port H. The spring B then forces back the plunger A and the fuel is injected abruptly. When the engine is running at a high speed there is little time for the transfer of oil through the orifice G, so a high pressure is generated in the compression chamber D and the injection is correspondingly violent; but when it is running slowly the oil has more time to pass, a lesser pressure is produced, and the fuel is injected more gently, which is conducive to the good running of the engine.—*December 31st*, 1934.

TURBINE MACHINERY.

421,793. September 13th, 1934.—TURBINE BLADING, Escher Wyss Maschinenfabriken Aktiengesellschaft, Zurich, Switzerland.

The inventors say that experiments they have made on the blading of steam turbines show that the conditions of flow on the back of the blade are a matter of considerable importance, as regards the production of loss and, in particular, it was found that the changes in the pressure on the backs of the blades must not exceed a given amount if the loss of energy in the blade passages is to be as small as possible. They consequently

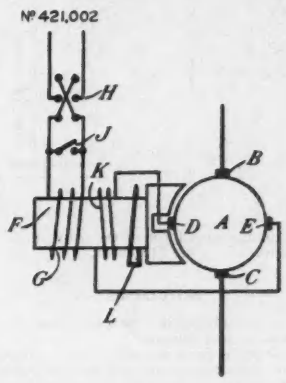


advocate that the cross-sectional areas of flow at the inlet and outlet of the blade passages be so dimensioned that the pressure at the inlet of each rotor blade passage is higher than the pressure at the outlet of such passage by about 2 to 10 per cent. of the total pressure drop available for that stage. The cross-sectional area of the passage at the middle of the width of the blades should be 1·4 times greater than the outlet passage, and the line A A forming the inlet and outlet lips of the blade should intersect the centre line at a point less than the width of the opening at the centre of the passage.—*December 31st*, 1934.

DYNAMOS AND MOTORS.

421,002. August 21st, 1933.—ELECTRICAL EQUIPMENTS FOR LIFTS, HOISTS, AND THE LIKE, Giuseppe Massimo Pestarini, c.o. C. T. San Giorgio, Genoa-Sestri, Italy.

This invention relates to electrically operated lifts, hoists, and the like, and has for its object to construct improved equipment which is operated by direct current of constant intensity. A is the armature having a pair of primary brushes B and C, and brushes D and E approximately midway between the primary brushes. Poles indicated diagrammatically at F in line with, or producing a resultant flux in line with the secondary brushes D and E, are provided with a winding G excited from a source of supply through a reversing switch H and a shunting switch J. The source of supply may be conveniently provided by the inclusion of the winding G in the same constant-current circuit as the armature. The field set up by the winding G generates an electromotive force between the brushes B and C, and normally constitutes the back electromotive force of the motor. The magnetic circuit through the pole F is arranged to be highly saturated for fluxes a little greater than the normal working fluxes, so as to provide a limiting value of motor torque by limitation of flux. A winding K is also arranged on the poles F and is connected to the brushes D and E. The current flowing through the winding K is that due to the electromotive force generated between D and E, due to the armature conductors rotating in the armature field set up by the current flowing between B and C. The winding K is arranged to produce a flux which opposes that of the winding G and produces an electromotive force between the brushes B and C in the same direction as the applied voltage. The winding K has a sufficient number of turns normally to swamp the effect of any flux set up by the armature current along the axis D E when the winding G is rendered inoperative, *i.e.*, by closure of switch J. The term

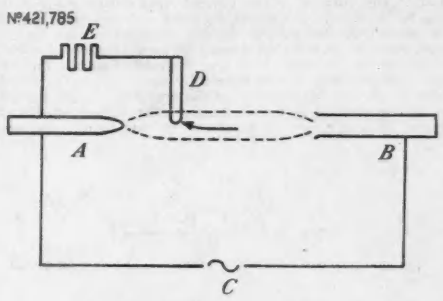


"secondary armature flux" is intended to refer to the flux set up by the armature current along the direction D E. Similarly, the term "primary armature flux" refers to the flux set up along the axis B C. When the lift is at rest the armature is normally short circuited. By opening the short circuit and exciting the winding G, the motor will rotate in one direction or the other, according to the direction of the exciting current. When it is desired to stop the lift, the winding G is short circuited. When this occurs the winding K predominates and tends to reverse the secondary flux and hence the torque, so that the motor will exert a braking action. This will, of course, reverse the back electromotive force between the primary brushes B and C, so that it will be in the same direction as the applied voltage. If, however, the applied voltage is obtained from the secondary brushes of a metadyne transformer or other constant current generator of suitable characteristics, the effect of this will be to return the power to the supply system. The damper winding L prevents sudden variations in the flux, and enables smooth starting and stopping to be obtained.—*December 12th*, 1934.

SWITCHGEAR.

421,785. June 11th, 1934.—ARC-EXTINGUISHING DEVICES FOR ELECTRIC SWITCHES, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

The object of this invention is to quench the arc which may be formed when two contacts in a high-voltage circuit are separated, such as in opening a switch. The contacts are shown at A and B and are in the power circuit C. An auxiliary electrode D, connected with one of the contacts through an impedance E is inserted in the path of the arc. It may be introduced either mechanically or the arc may be deflected towards it. The result is that the arc attaches itself to the auxiliary electrode and is quenched by the impedance. As experiments have shown, it is possible by means of the process described to extinguish a stabilised arc with perfect reliability with outputs of 50 kW



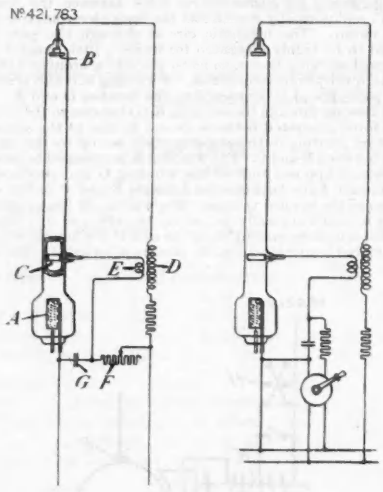
and pressures of 2000 V, for example. For this purpose, a bar-shaped auxiliary electrode, connected through a 200–300 ohm resistance to one electrode, was introduced into the arc column. Extinction took place immediately on the introduction of this electrode, without it being necessary to employ any artificial extinguishing means, such as compressed air, oil, water, or the like. At very high voltages, there is a danger, however, that after periods in which natural de-ionisation of the gas path may take place, the potential drop between the auxiliary electrode and cathode is already so great that a new arc may be formed between these two through which the entire discharge will then take place. It may be found necessary under these conditions, to reduce the de-ionisation period by artificial means of a known kind.—*December 31st*, 1934.

LIGHTING AND HEATING.

421,783. June 5th, 1934.—ELECTRIC DISCHARGE LAMPS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

This invention is concerned with electric discharge lamps, which are of such a length that they will not start glowing at the voltage at which they are intended to run. The cathode is shown at A and the main anode at B. There is an auxiliary anode at C and a controlling impedance at D. The anode C is connected with the supply mains through a winding E and resistance F. It is also connected with a condenser G. When current is switched on the condenser becomes charged and a discharge also takes place between the auxiliary anode and the cathode on account of their comparative proximity. The con-

denser then discharges through the winding E and the sudden rush of current acts on the impedance winding, as in a trans-

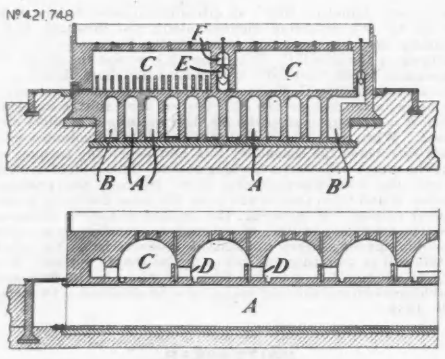


former, and a voltage is produced at the main anode B sufficient to start the lamp.—*December 31st*, 1934.

BUILDING.

421,748. August 2nd, 1933.—BRICK KILNS, J. Walmsley, 6, Cranbrook-street, Oldham.

In this brick kiln the firing chambers and the drying chambers are built as one structure with the object of conserving heat. The drying chambers A A are built below the ground level and

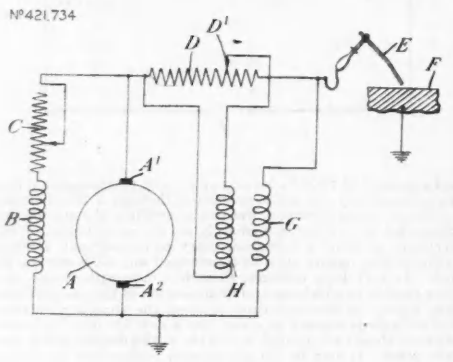


are flanked by the main flues B B. Above, there are the firing chambers C C, which intercommunicate through the openings D D. A steam flue is provided at E and a hot air flue at F. It will be seen that the drying chambers will be heated by conduction from the firing chambers.—*December 31st*, 1934.

WELDING.

421,734. June 29th, 1933.—GENERATORS FOR ARC WELDING, J. H. Holmes and Co., Ltd., North Drive, Hebburn-on-Tyne, Durham, and A. C. Fenwick, 3, South-drive, Hebburn-on-Tyne.

In electric arc welding it is desirable that the voltage characteristic of the welding generator should be such that the drop in voltage from the open circuit value is substantially proportional to the current as the current varies from no-load up to the full load value for which the machine is set, and that the drop in voltage due to any further increase in this current should limit the current sufficiently to prevent sticking during the striking of the arc. It is also desirable that the fluctuations in the welding current caused by variations in the length of the arc, due to unsteadiness of the operator's hand, unevenness of the surface to be welded, or other causes, should be reduced to a minimum. As shown in this figure, a direct-



current generator A has a shunt field winding B provided with a field-regulating resistance C. One output terminal A^1 of the generator is connected in series with a resistance D to the welding electrode E. When, as is usual, the second electrode F constitutes the body to be welded and this body is earthed, the other output terminal A^2 of the generator is connected to earth as shown. When, however, the electrode F is not earthed, it is connected directly to the terminal A^2. The generator A is provided with an auxiliary field winding G which is connected to the electrode E and to earth, so that it is in parallel with the arc, and the flux produced thereby is in the same direction as the flux produced by the shunt field winding B. The two windings B and G are so proportioned that, on open circuit, they combine to furnish the flux for the striking voltage of, say, 70 volts. When the electrodes E and F are in contact during strking, the auxiliary field winding G is short circuited, so that, under short-circuit conditions, the machine is a plain shunt-woumd generator with a rapidly falling voltage characteristic and the short-circuit current is correspondingly limited. When the arc is struck the auxiliary field winding G is energised in accordance with the voltage drop across the arc, say, 25 volts, and supplies a suitable proportion of the generator flux. The auxiliary field winding G connected across the arc responds rapidly to fluctuations in the welding current due to variations in the length of the arc, and serves, in addition to producing the desired voltage characteristic, to vary the generator voltage in such a manner as to compensate for these fluctuations and maintain the welding current substantially constant. Thus, the arc is stabilised and it is unnecessary to provide a relatively expensive choke coil in the welding circuit for this purpose. The arrangement of the two field windings B and G also ensures a rapid recovery voltage if the arc should be extinguished. When the series resistance D is made adjustable by the provision of a movable tapping point D^1, as is usually done in the case of a general purpose welding set suitable for supplying welding currents of widely different values, the generator may be provided with a third field winding H, which is connected in parallel with the resistance D and in a direction such that it produces a flux opposing the flux produced by the shunt field winding B.—*December 31st*, 1934.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. "Centrifugally Cast Iron," Mr. J. E. Hurst. 7 p.m.

INST. OF METALS.—The University, Sheffield. "The Manufacture of Pewter," Captain F. Orme. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "The Design and Equipment of Photo-elastic Laboratories, with a Brief Account of the Elements of Photo-elasticity," Professor E. G. Coker. 7.30 p.m.

KEIGHLEY ASSOC. OF ENGINEERS.—Queen's Hotel, Keighley. "Economic Uses of Tungsten Carbide Tools," Mr. J. H. Garnett. 7.30 p.m.

MANCHESTER ASSOC. OF ENGINEERS.—Engineers' Club, Manchester. "Well Boring," Mr. R. L. Matthews. 7.15 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Mining Inst., Newcastle-upon-Tyne. "Fuel Consumption and Maintenance Costs of Diesel and Steam-engined Vessels," Messrs. L. J. Le Mesurier and H. S. Humphreys. 6 p.m.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "Ice Formation in Carburettors and Induction Systems," Mr. W. C. Clothier. 6.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Sir Gilbert Walker. 9 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Civil Aviation in India," Mr. J. A. Shillidy. 4.30 p.m.

MONDAY, FEB. 11TH.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. Discussion on "The I.E.E. Wiring Regulations (Tenth Edition)," Opener, Mr. H. J. Cash. 6.30 for 7 p.m

INST. OF METALS.—At 39, Elmbank-crescent, Glasgow. "Recent Developments in Electric Furnaces for Non-ferrous Metals," Mr. A. G. Robiette. 7.30 p.m.

TUESDAY, FEB. 12TH.

HULL ASSOC. OF ENGINEERS.—At Municipal Technical College, Park-street, Hull. "Diesel-engined Trawlers," Mr. Oswald Waus. 7.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—King's Head Hotel, Coventry. "Modern Steel Motor Car Body Building," Dr. G. L. Kelley. 7.30 p.m.

INST. OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—At Municipal College, Ormerod-road, Burnley. "Modern Iron and Steel Works," Mr. A. Benfield. 7.15 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Electric Arc Welding in General Engineering," Dr. J. Orr. 7.30 p.m.

INST. OF MARINE ENGINEERS.—85–88, The Minories, E.C.3. "Welded Steel Frames for Marine Engines," Mr. C. H. Stevens. 6 p.m.

INST. OF METALS.—James Watt Memorial Inst.. Birmingham. Symposium on Pickling Processes. 7 p.m.

INST. OF METALS.—Armstrong College, Newcastle-upon-Tyne. "Melting Furnaces for Non-ferrous Metals," Mr. G. L. Cassidy. 7.30 p.m.

INST. OF METALS.—Y.M.C.A., Swansea. "Design of Rolling Mills for Cold Rolling of Metals, both Ferrous and Non-ferrous," Mr. C. E. Davies. 6.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield 1. "Waste Heat Boilers," Mr. F. Jones. 7.30 p.m.

WEDNESDAY, FEB. 13TH.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Informal meeting. Discussion, "Cross Traffic and Road Intersections," Mr. H. W. S. Husbands. 6 p.m.

INST. OF ENGINEERS-IN-CHARGE.—St. Bride Inst., Fleet-street, E.C.4. "Boiler Water Problems," Mr. J. S. Merry. 7.30 p.m.

INST. OF HEATING AND VENTILATING ENGINEERS.—In Lecture Theatre, London School of Hygiene and Tropical Medicine, Keppel-street, Gower-street, W.C.1. "An Investigation of the Discharge of Air from Ports in a Trunkway," Dr. Ezer Griffiths and Mr. R. W. Powell. 2.30 p.m.

INST. OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Joint meeting with the Sheffield Soc. of Engineers and Metallurgists, in the Mappin Hall, the University, Sheffield. "The Machining of Heavy Forgings," Mr. W. Locke. 7.30 p.m.

LIVERPOOL ENGINEERING SOC.—9, The Temple, 24, Dale-street, Liverpool. "Heat and Sound Insulation," Mr. A. Lindsay Forster. 6.30 p.m.

SOC. OF CHEMICAL INDUSTRY: FOOD GROUP.—At London School of Hygiene and Tropical Medicine, Keppel-street, Gower-street, W.C.1. Dr. H. B. Cronshaw will open discussion on "Training of the Food Technologist." 8 p.m.

THURSDAY, FEB. 14TH.

INST. OF AUTOMOBILE ENGINEERS.—At Merchant Venturers' Technical College, Bristol. "A Study of Road Performance," Mr. Maurice Platt. 7 p.m.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION; INST. OF MECHANICAL ENGINEERS: MIDLAND BRANCH; and INST. OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—Annual joint meeting. Central Hall, Corporation-street, Birmingham. "The Houston Mount Everest Flight," by the leader of the expedition, Air Commodore P. F. M. Fellowes, D.S.O. 7 p.m.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. "The Application of Propeller Fans to the Cooling of Electrical Machines," Mr. R. Poole. 5.30 for 6 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—85–88, The Minories, E.C.3. "Lubrication of Marine Engines," Mr. E. R. Chamberlain. 7 p.m.

INST. OF METALS.—Joint meeting with the Electro-Depositors' Technical Soc., at Rooms of Soc. of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. "The Protection of Metals by Coatings," Dr. W. H. J. Vernon. 7.30 p.m.

FRIDAY, FEB. 15TH.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Lecture, "The Application of Proof Stress to Modern Aircraft Material," Mr. H. J. Alpe. 7.30 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Prof. W. G. Constable. 9 p.m.

SATURDAY, FEB. 16TH.

INST. OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Engineers' Club, Manchester. "Castings," Messrs. W. Machin and M. Oldham. 2.45 p.m.

MONDAY, FEB. 18TH.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOC.—Visit to new works at Hope of G. and T. Earle, Ltd. Leave by motor coach from Midland Station, Sheffield, 11 a.m.

INST. OF METALS.—Joint Meeting with Inst. of Automobile Engineers, at 39, Elmbank-crescent, Glasgow. "Recent Advances in Metallurgy," Dr. A. McCance. 7.30 p.m.

MONDAY, FEB. 18TH, TO FRIDAY, MARCH 1ST.

BRITISH INDUSTRIES FAIR, 1935.—London Section. Daily.

TUESDAY, FEB. 19TH.

FARADAY HOUSE OLD STUDENTS' ASSOC.—Wharncliffe Rooms, Hotel Great Central, N.W.1. Annual dance. 8 p.m. to 2 a.m.

ILLUMINATING ENGINEERING SOC.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Time Characteristics of Tungsten Filament Lamps for Flashing Signals, Signs, and Beacons," Messrs. J. M. Waldram and J. M. Sandford. 7 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND CENTRE.—Hotel Metropole, Leeds. "The Removal of Smoke and Acid Constituents from Flue Gases by a Non-effluent Water Process," Dr. J. L. Pearson, Mr. G. Nonhebel, and P. H. N. Ulander. 7 p.m.

INST. OF SANITARY ENGINEERS.—Caxton Hall, Westminster, S.W.1. "Effluents," Mr. A. Sciver. 6 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield. "Inclusions in Steel," Dr. W. R. Maddocks. 7.30 p.m.

WEDNESDAY, FEB. 20TH.

ENGINEERS' STUDY GROUP ON ECONOMICS.—Denison Hall, Vauxhall Bridge-road, S.W.1. "Planned Money," Sir Basil Blackett. 7.45 for 8 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Water Supplies from Underground Sources," Lieut.-Colonel J. D. Restler. 8 p.m.

THURSDAY, FEB. 21ST.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOC.—Visit to works of Belliss and Morcom, Ltd. 2.30 p.m.

FRIDAY, FEB. 22ND.

INST. OF CHEMICAL ENGINEERS.—Hotel Victoria, Northumberland-avenue, W.C.2. Annual general meeting, 11 a.m.; Presidential Address, "Chemical Engineering in Explosives Manufacture," Mr. W. Macnab, 11.45 a.m.; luncheon, 12.45 p.m.; "The Historical Development of Distilling Plant," Dr. A. J. V. Underwood, 2.15 p.m.; annual dinner, 7 for 7.30 p.m.

INST. OF MARINE ENGINEERS.—Connaught Rooms, Great Queen-street, W.C.2. Annual dinner. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "The Repair of Small Boilers and Pressure Vessels," Mr. F. A. Glidewell. 7.30 p.m.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

THE ENGLISH ELECTRIC COMPANY has received a contract from the States of Guernsey Electricity Department to supply an 8-Q type Fullagar engine, developing 1960 h.p., which will be direct coupled to an "English Electric" 1375-kW alternator, generating power at 6600 volts, three-phase, 50 cycles.

CROMPTON PARKINSON, Ltd., has received the order for the 25–50-cycle frequency change at Llewellyn Nixon's Collieries, South Wales. This is the first colliery group in the area to be changed over, and comprises four collieries. The contract covers the provision of 100 motors, totalling 5000 h.p., including seven haulage motors of 250 h.p. each.

BRITISH INSULATED CABLES, Ltd., have received an order for 34 tons of cadmium-copper line wire for Lithuania, the wire to be in accordance with British Post Office specification; and an order to supply, lay, and joint 20 miles of 33-kV cable, with pilot and telephone cable, between Ocker Hill and Brierley Hill and Ocker Hill and Slow Heath.

MORRIS MOTORS, Ltd., Cowley, Oxford, have received orders for Morris industrial engines from the Anglo-Swedish Electric Welding Company, Ltd., Greenwich; J. H. Holmes and Co., Ltd., Hebburn-on-Tyne; Lansing, Bagnall and Co., Victoria-street, S.W., engines for tractors for the L.M.S. Railway; and Murex Welding Processes, Ltd., Walthamstow, E.17.

STOTHERT AND PITT, Ltd., Bath, have recently secured two further orders for multi-bucket excavators suitable for dealing with clay. One of the machines is to be supplied to the Associated Portland Cement Manufacturers, Ltd., and will have a guaranteed output of 30–35 tons per hour. It will be capable of digging to a depth of 16ft. The other machine is being made to the order of Colthurst, Symons and Co., Ltd., of Bridgwater, Somerset, and will have an output capacity of 25 cubic yards per hour. In each case the drive will be by oil engine.

LAUNCHES AND TRIAL TRIPS.

SAN AMADO, oil tanker; built by Blythswood Shipbuilding Company, Ltd.; to the order of Eagle Oil and Shipping Company, Ltd., London; dimensions, 442ft. 6in. by 60ft. by 32ft.; to carry oil in bulk. Diesel engines, Burmeister and Wain type; constructed by John G. Kincaid and Co., Ltd., Greenock. Trial trip, January 30th.

WAIRANGI, motor vessel; built by Harland and Wolff, Ltd.; to the order of Messrs. Shaw Savill and Albion Company; dimensions, 515ft. by 70ft. by 43ft. 4½in.; to carry cargo and passengers. Diesel engines, Harland-B. & W. type; constructed by the builders. Trial trip, recent.